ACHIEVEMENTS IN ANONYMITY —
UNSUNG INDIAN SCIENTISTS

A collection of biographical articles edited by

Kollegala Sharma *and* Bal Phondke

PUSHING back the frontiers of science is not a recent phenomenon in India as is unfortunately believed. Even in the yesteryears, before the generous support to the pursuit of science became a governmental and societal priority, a number of Indian intellectual giants made outstanding contributions to mankind's knowledge base.

Some of them were accorded due recognition, even coveted laurels. Thus, Roman, Bose, Saha, Bhabha, Bhatnagar became household names.

However, for every such luminary there have been ten other silent workers, toiling in the shadows, unmindful of any acclaim. Achievers in their own right, these men and women went about quietly laying the foundation for the huge edifice that Indian science today is. With encomiums lacking, encouragement rare and with only enthusiasm to spare, they practised and propagated science far and wide. Unsung in life, unremembered in death, they left behind a legacy that has helped advance the frontiers of science.

This collection of their lives and times is a belated tribute to the forgotten Indian scientists.

"Full many a gem of purest ray serene,
The dark unfathomed caves of ocean bear;
Full many a flower is born to blush unseen,
And waste its sweetness on the desert air." '
— Thomas Gray

The likes of Sir C. V. Raman or Sir J. C. Bose have sparkled in Indian science. But there were also others, gems in their own right, whose brilliance never caught the public eye. These men who remained in the shadows worked to spread the culture of science far and wide in the country. Societal recognition, they never waited for, and went about zealously practising and propagating science. But for the dedication of their ilk, the huge edifice of Indian science would not have stood up. They were ingenious inventors, inspiring teachers, innovative researchers and enterprising engineers who silently inculcated scientific temper thereby creating a climate that allowed modern science to take firm root in India. We feel privileged to have had this opportunity of bringing to light the lives and contributions of these scientists who for long have remained in the dark alleys of public memory. Presenting biographical sketches of these unsung scientists to provide inspiration to the budding Edisons and Einsteins alike would, we think, be the best way of paying a belated tribute to these luminaries of yesteryears. True, this volume does not cover all those forgotten scientists, but the hope is that this tome would catalyse

readers into ferreting out other gems that may still be languishing in the darkness of the past.

K.S.

B. P.

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Content

To give and not to count the cost;
To fight and not to heed the wounds;
To toil and not to seek for rest;
To labour and not ask for any reward
Saint Ignatius Loyola (Prayer for Generosity)

DEVOUT BOTANIST

Shankar Purushottam Agharkar

KOLLEGALA SHARMA

Be it the space technology, supercomputers, superconductors or the genetically engineered supercrops, Indian scientists have demonstrated their prowess in handling any modern technology. It is an amazing advance for a country which did not have even a dozen institutions for teaching modern science at the turn of the century. Thanks to visionaries like Shankar Purushottam Agharkar, who spent their whole life and even fortunes on promot-ing Indian science, India today is a front runner in science and technology among the developing nations.

Shankar Purushottam Agharkar was born on November 18, 1884, in Malvan, a remote village, in Ratnagiri district of Maharashtra state. This village boy's rise to the top of one of the prestigious research departments in the far-off Calcutta is a fascinating story of his determined effort to learn science and do research against all odds. Hurdles were there even during his school days. He had to have his schooling in half-a-dozen schools because his father who was an overseer in the Public Works Department was frequently transferred from place to place. Shankar Agharkar had to not only learn different languages, but also had to cope with tcacherless schools. At least in one instance Shankar had to take the onus of teaching his classmates as the two teachers in his school were either busy in other activities or uncaring. Inspite of all these odds, Shankar passed his matriculation from the Government High School at Dharwar and joined the Elphinstone College. Bombay for a B.A. degree. He passed the B.A. degree also in first class with botany, zoology and geology as optional sub-jects. It is during this period that Shankar was attracted to biological sciences. In 1909, he took his M.A. degree, also from Elphinslone College. Immediately after this he became a lecturer in the biology department of the college.

The three years of his lecturership at Elphinstone College provided enough leisure time for Shankar to pursue research. There were long holidays between teaching sessions and Shankar put these to good use for explor-ing the nearby Western Ghats for animals and plants. He was quite adept in such surveys and his first scientific accomplishment had resulted from one such excursion into the wild. During one such foray into the Ghats, Shankar found a new species of fresh water jelly fish —*Limnocnida indica* Annadale. The jelly fish was till then known to occur only in African rivers.

He published his findings in the British science journal, *Nature,* in 1912. From then on he was hooked onto research. So much so that he refused, against the wishes of his family, a government job with a secure salary and pen-sion benefits, only because it provided no opportunities for research!

While at Elphinstone College, Shankar had sought help from Dr Annadale, Superinten-dent of the Indian Museum at Calcutta, for identifying the animals and plants that he collected from the wild. Annadale's friendship proved a boon. Annadale provided Shankar with opportunities for visiting Calcutta by ap-pointing him a honorary correspondent of the museum. He also taught Shankar, during such visits, various techniques of collection, preservation and microscopic examination of plant and animal specimens. In 1913, Shankar was invited to attend the centenary celebrations of the Indian Museum, and the occasion proved to be a turning point in his life. He stayed back at the museum to help Dr Annadale in studying some net-veined midges collected from Kashmir. It turned out that the insects were of a new species —*Philorus bioni* Agharkar — not previously reported from India. Though published so long ago, the work remains re-markable because of the accuracy of the details recorded by Agharkar. Agharkar's collection of plants and animals from the Western Ghats also contained a number of unknown species. The devout botanist's name remains immortal in the names of these new species of plants and animals — two flowering plants (*Dicroea agharkarii* and *Musa agharkarii)* one fungus *(Mitrula agharkarii)* and one centipede (*Cryptorhyptops agharkarii)* — he discovered.

With such successful accomplishments, it was only natural for Shankar Agharkar to stay back at the museum. But that was not to be for long. In 1913, the Selection committee for the Ghosh professorship of Botany at the Calcutta University was in a fix. There were no suitable candidates in the University. The candidate had to be an Indian and distinguished in Botany — difficult qualifications to come by in those days. Sir C. V. Raman, who was then the Palit Professor of Physics at the University, suggested young Agharkar's name to the Chairman of the Committee, Sir Asutosh Mookerjee. Shankar was asked to apply for the professorship and was told that he would have to go to Germany for training in case he accepted the professorship. Shankar's love for research made him to accept the offer instantaneously, though he knew that he would be castigated for 'crossing the seas' inspite of being a Hindu. Shankar sailed for Germany on May 2, 1914, for a two-year training course.

Unfortunately, Shankar's sojourn abroad proved to be longer than anticipated because of the First World War which broke out imme-diately after his arrival at Germany. He was imprisoned for three years and his studies suffered. However, he succeeded in getting his Ph.D. from the Berlin University in 1919. His thesis which dealt with the means and mechanisms of dispersal and distribution of xerophytes of North-West India was appreciated very much by his examiners; Shankar spent the next year touring Europe and England, visiting the various Botanical gardens including the famous Royal Botanical Gardens at Kew, London. He also went on exploration in the European mountains collecting rare and valuable plant materials. His rich collection of plant materials which he gifted to the Calcutta University is considered as one of the finest made by any single individual.

After his return from abroad in 1920, Professor Agharkar, as Shankar came to be known among his students and colleagues became an inseparable part of the Botany department for the next quarter century. The department lit-erally bloomed under his stewardship into becoming one of the finest plant sciences research institutions. “He was”, says D. Chatterjee, an erstwhile student, “a mine of botanical information and a person who could stimulate and infuse the proper scientific and critical attitude among his students”. A letter that Professor Agharkar wrote to *Science and Culture* in 1955, at the ripe age of 71, stands testimony to that statement. In that letter he corrected the wrong conclusion to which the author of a note published earlier had come by studying inadequate number of Tamarind flowers.

More than his scientific prowess, Professor Agharkar’s contribution to Indian science lies in the great administrative and organizational skills he displayed in running various scientific organizations in the country. Besides being the Ghosh professor of Botany at the Calcutta University for 26 long years, he also served as the Secretary or President of many professional scientific bodies. It is largely due to Professor Agharkar’s efforts as the Secretary of Indian Science Congress Association that today the London Overseas scholarship is available to Indians. Till 1931, the scholarship was awarded only to British nationals though the funds for the same came from contributions by many Indian princes.

A great nationalist, Agharkar would not let any harm come to Indian science or scientists. That is why he took up cudgels against the British authorities who proposed to shift the rare type-specimens from the Sibpur Herbarium, Calcutta, to the Royal Botanical Gardens at Kew, London. He pointed out the damage it could cause Indian botany and forced the authorities to abandon the idea. It was an act but for which many of the herbaria now under the charge of Botanical Survey of India would have become poorer and the specimens would have been beyond the reach of Indians stilting the growth of botany in India.

Professor Agharkar retired from Ghosh professorship at Calcutta in 1946. But his activities did not stop. He returned to Bombay and started teaching Post-graduate students of Bombay University. Meanwhile, in 1946, some distinguished members of the Indian Law So-ciety at Pune decided to start an organization for the promotion of scientific research in the City. Their obvious choice to head the institution was Professor Agharkar. He was ‘unani-mously elected as the Founder-Director’ of the proposed Maharashtra Association for the Cul-tivation of Science (MACS) by the Committee. Soon the Association flowered into a fine re-search centre under the leadership of Agharkar. “He spent every second of his life and his last farthing he earned for the cause of the Institute”, says P. V. Sukhatme, former President of MACS. His office at the Association never had a fan, for he considered it a luxury. Tidy, regular and systematic, he set an example for others to follow. Even at his ripe old age he would often join younger colleagues for botanical collections in the hills. “It was a pleasure and also educative to accompany him in field excursions”, recollects a student.

Professor Agharkar remained the leader of the Institute till I960 when he retired because of the failing health. In 1956, Professor Agharkar had to undergo an operation for cancer. Even when death was knocking at his door, he was busy working with the Chief Palynologist of the Oil and Fuel commission on the origin of the Bengal flora. When he was diagnosed as having the disease, Agharkar quietly prepared his will,

donating all but the bare necessities for his wife to a trust in favour of the MACS. He even visited the Association laboratories to enquire about the progress of various research projects under way just a few days before his death. He breathed his last on 2 September I960. It is befitting that the Institute for which he had devoted his life and fortune should remember him for all the time to come. The MACS renamed its research institute as ‘Agharkar Research Institute’ on September 10, 1992 in honour and memory of the late scientist who had nursed it so fondly.

INDIAN EDISON

Shankar Abaji Bhise

J. B. KULKARNI

During the British rule India lagged behind the Western countries in many respects for several reasons. Nevertheless, it had its own crop of capable scientists. Men like J. C. Bose and P. C. Ray had achieved unique distinction in the field of science. To the list of such illustrious scientists can be added the name of Shankar Abaji Bhise who brought glory to India through his inventions at home and abroad.

Bhise had an aptitude for science since his childhood. At the age of fourteen, he con-structed a small apparatus which made coal gas at his home. At sixteen itself, he had made up his mind to sail for England or America and make a name as an inventor.

Bhise did achieve that. Before Bhise turned his attention to science, he worked for some time on optical illusions. This was during the years 1890-95. He would show the public transformation of one solid object into another. In fact, he even arranged such a show at the Free Trade Hall at Manchester, England. These demonstrations were considered superior to those invented by Europeans and were highly appreciated by Mr Alfred Webb, the President of the Tenth Indian Congress which met in Bombay in 1894. For these demonstrations, Bhise was honoured in Bombay with a gold medal.

While in Bombay, Bhise founded a science club and started publishing a science magazine in Marathi called *Vividh Kala Prakash* through which he conveyed the importance of science to the common people. During this period, an opportunity to show his talents came his way. A news of a competition offering a prize for an invention of an automatic machine that could weigh and deliver accurately from bulk such materials as sugar and flour appeared in *Inventors’ Review and Scientific Record*, London. Bhise sent in his design. There were several other competing entries, but Bhise’s was considered the best. This also created a sensation in the industry, and Bhise became a noted figure, touted as an inventive genius. More importantly, his achievement was noted in America too with the American science journal *Scientific American* reporting on his achievement.

Bhise’s most acclaimed invention is that of type-casting and composing machines. The type-casting machines of those days were slow. A type-casting machine of that

period could cast only 150 types per minute. Despite efforts by many inventors, no improvement could be made in the machine. Therefore, Bhise took to making a multiple casting machine — a machine that can cast not just a single type at a time but many types. He invented one such machine which cast thirty two different types simultaneously. However, people did not believe his claims and he was challenged by engineers of the Caston Type Foundry, a leading type-casting firm in London, U.K. Bhise accepted the challenge, set up his own foundry, the Bhiso-Type Ltd., with financial assis-tance from London and produced a machine in 1908. This silenced his critics as well as the English engineers. The machine could automatically cast and assemble 1200 different types every minute. *Caxton*, a leading printing magazine of those times remarked of his achievements, "that a native of India should produce results which the most able engineers of the world have so far failed to accomplish."

Bhise neither looked back nor did he stop in his efforts at inventing a better casting machine. He went even further and invented an automatic dwell machine, and obtained a patent for it. This invention was used on a wide scale in all the Bannerman type-casting machines of England.

These unique achievements led the Indian National Industrial Congress to invite Bhise as a guest of honour in its annual convention held at Madras, in 1908. It also evoked response from many other quarters as well. At the personal request of Shri Gopal Krishna Gokhale and Dadabhoy Naoroji, Sir Ratan Tata agreed to finance Bhise's projects and in 1910, a Tata-Bhise invention syndicate carne into being to finance Bhise's inventions.

Bhise's next invention was the rotary multiple type-caster. It could automatically cast and assemble over 3000 different types every minute, which was more than what several other European machines of similar kind could do at that time. Unfortunately, this invention could not be furthered and it ran into financial difficulties.

Bhise had his mind elsewhere too. At that time one of the stumbling blocks in type-casting was the non-availability of a mould which would suit all sizes of types. Bhise worked on it and succeeded in making one such mould in 1914 — an outstanding invention which was acclaimed in printers' journals in Britain and America.

Bhise visited America for a short time during the First World War In America he came into contact with Lala Lajpat Rai, the Indian leader who inspired him to make many more such inventions. In America, at the request of the Universal Type Caster Corporation, Bhise invented a new machine in just three days. He also invented there a machine for casting leads and rules. This new type-caster had just 250 parts, much less than what British and American machines were made of. A quote in *Scientific American* reflects the mood of Americans in response to Bhise's inventions. It wrote: "While India has achieved brilliant success in science, literature and arts, it had given little to the world in the way of invention ... whatever may have been the opinion of the world; the work of Mr Bhise should do much to dispel the illusion."

In 1920, Bhise started the Bhise Ideal Type Casting Corporation in New York to develop and market the type-casting and lead rule-casting machines. He spent over 80,000 dollars on this venture. His efforts were not in vain. Mr W. Ackerman of the Linotype Company of America had this to say about Bhise. He said, "He (Bhise) has now solved a problem which had been the dream of type-machine inventors for many years." Besides inventing type-caster machines, Bhise also took interest in chemistry and

elec-tricity. His first invention in these fields was a washing compound called ‘Rola’. This was in 1917. He sold all rights of this invention to an English firm. He also invented an electrical gadget which separated various gases from air. His other electrical invention was an engine which derived electrical energy directly from sunlight. He also invented a single process of transmitting photos telegraphically but could not market it for want of finances.

In addition to these inventions, Bhise also developed a medicine named ‘Atomidine’ which was widely used in the First World War His desire to set up a firm and manufacture this drug in India, however, did not see the light of the day.

Because of these and other achievements, Americans called Bhise the Edison of India. He believed strongly in the unity of all religions and hated religious hatred. Bhise had to his credit 200 inventions, for about 40 of which he took patents. He died in New York on 7 April 1935 at the age of 68.

SILENT SCIENTIST

Debendra Mohan Bose

HASAN JAWAID KHAN

A man of few words, unassuming, a silent worker and a strikingly handsome figure is how people who knew Debendra Mohan Bose describe him. Yet today very few even know about, let alone remember, the man who was honoured in India and recognised abroad for pioneering researches in the field of cosmic rays, artificial radioactivity and neutron physics. He built the first indigenous cloud chamber to track ionizing radiations way back in the 1920s. He is also remembered as the scientist who more than once came close to making major breakthroughs which later won the Nobel Prize.

If one were to talk about formative influences on young Debendra there would be no dearth of it. He had illustrious peers all around him. Debendra was born in Calcutta on 26 November 1885. His father, Mohini Mohan Bose, who was a practising Homeopathic physician, was among the first Indians to have visited the United States of America. His uncle, Ananda Mohan Bose, was the first Indian Wrangler in Mathematical Tripos from Cambridge. Debendra Mohan’s mother was Subarnaprabha Bose, younger sister of Sir Jagadis Chandra Bose, the renowned physicist and plant physiologist. J. C. Bose lived in the same house with Debendra’s family at 64/1, Mechuabazar Street. For some time P. C. Ray, the famous chemist and a dose friend of J. C. Bose too stayed in the same house.

In 1901 the family shifted to 92/3, Upper Circular Road. P. C. Ray who had by then shifted to 91, Upper Circular Road founded the Bengal Chemical and Pharmaceutical Works. Young Debendra had the good fortune of interacting with people like Nil Ratan Sircar, Rabindranath Tagore, Loken Palit, Sarala Debi, Charuchandra Dutta and Sister Nivedita all of whom were regular visitors to P. C. Ray’s house. Debendra Mohan was also inspired by the renowned Swedish scholar M. Hammergren who had come to gather material about Raja Rammohun Roy and the Brahmo Samaj.

Serious business apart, young Debendra was a versatile sportsman too. He was one of the founders of the Sporting Union Club and the captain of the club's hockey team in 1905-06. While a student of the Presidency College he excelled in cycling, football and cricket.

Debendra Mohan's uncle J. C. Bose had by far the most formidable influence in shaping his life and career. It had been tacitly assumed during his boyhood that Debendra Mohan would undergo training in science to enable him to carry on his uncle's pioneering re-searches. But fate intervened. Debendra's father died in 1901. Now it became necessary for him to take up a profession to support his family. After he passed his F.A. examination from Presidency College in 1902 J. C. Bose •suggested that Debendra Mohan join the Ben-gal Engineering college at Sibpur. But after one year of study there Debendra went down with a severe attack of fever and abandoned the idea of returning to the malaria-infested place again.

With the aim of moving on to the engineer-ing college in Poona, Debendra got himself admitted to the third year B.Sc. class of Presi-dency College in 1903 with Physics as the main and Geology as one of the subsidiary subjects. He passed the B.Sc. examination with honours in 1905 and the M.A. examination in Physics in 1906 standing first in Calcutta University. For a year thereafter he worked as a research scholar under J. C. Bose and obtained his initiation into his uncle's investigations in plant physiology.

The very next year, in 1907, Bose got an opportunity to go to England where he was admitted as an advanced student in Christ's College, Cambridge. He worked in the Cavendish Laboratory for some time under the guidance of Sir J. J. Thomson. Here he had the opportunity of observing C. T. R. Wilson develop his technique of employing the cloud chamber for photographing the tracks of ionizing particles. In 1910, he joined the Royal College of Science, London from where he obtained in 1912 the A.R.C.S. diploma as well as B.Sc. in physics with a first class.

On his return to Calcutta, in 1913, he joined the City College as Professor of Physics. Soon thereafter, in April 1914, he was appointed Rash Behari Ghosh Professor of Physics at the Calcutta University. Sir C. V. Raman was a Palit Professor in the same department. Besides, there were a number of brilliant lecturers like P. N. Ghosh, Satyendranath Bose, Meghnad Saha and S. K. Mitra. Soon after Debendra Mohan was awarded the Ghosh Travelling Fellowship for two year's advanced study in Physics abroad. He worked with Professor E. Regener at the Berlin University.

Unfortunately, the First World War broke out and Bose got trapped in Germany for quite sometime. However, he was allowed to continue his studies under Professor Regener who assigned him the task of constructing a new cloud chamber. His training under C. T. R. Wilson proved useful. He managed to design a modified Wilson-type cloud chamber to photograph the tracks of recoil protons produced during the passage of fast alpha particles through a hydrogen filled chamber. However, he was not permitted to present his Ph.D. thesis until the War ended.

During his stay in Germany Bose had the rare opportunity of attending the lectures of Max Planck, Albert Einstein, Rubens, Warburg, Hertz, Max Born and others, Bose obtained his Ph.D. *(magna cum laude)* degree from the Berlin University in March 1919 and returned to Calcutta to resume his Ghosh chair at the Calcutta University which he held till 1935. In 1935, Sir C. V. Raman left for Bangalore as Director of the Indian

Institute of Science. D. M. Bose succeeded him as Palit Professor of Physics. After the death of Sir J. C. Bose, a couple of years later he took over the mantle of Bose Institute as Director in 1938. He served the Institute with rare distinction for almost thirty years and retired in 1967 when his health began to fail.

D. M. Bose's main area of research was the study of nuclear collisions and disintegration by means of Wilson cloud chamber and photographic emulsions. He had seen C. T. R. Wilson develop his technique of employing the cloud chamber for photographing the tracks of ionizing particles. With the modified cloud chamber he developed in Germany Bose was able to verify Darwin's formula for collision between fast moving charged particles and molecules. He also made some studies on *delta* particles.

On his return to Calcutta Bose constructed an indigenous cloud chamber. He took pho-tographs of recoil tracks of radioactive nuclei during the process of *alpha* particle emission, and of the simultaneous emission of two ion-izing electron tracks from a helium atom, due to collision with an *alpha* particle. One photograph obtained by them was later interpreted as showing the disintegration of a nitrogen nucleus. Quite some time later P. M. S. Blacken, who went on to win the Nobel Prize, revealed the way in which a stable atomic nucleus can be disintegrated by bombarding it with alpha particles.

After joining the **Bose** Institute in 1938 Bose took up the study of tracks of cosmic ray ionizing particles using the photographic emulsion technique. He determined the mass of *mu* mesons by this method. With the departure of his associate Bibha Choudhri to England in 1945 this work was discontinued. Later on, Cecil Frank Powell, a British physicist was able to prepare such improved emulsions. Powell was awarded the Nobel Prize in Physics in 1950 for his investigations along this line. He actu-ally acknowledged the priority of Bose and Choudhri's work about *mu* mesons during the course of his lecture at Bose Institute sometime later.

Professor Bose made a special study of the plant physiological investigations of Sir J. C. Bose who had shown that plants respond to external stimulus. D. M. Bose suggested that there were certain biochemical processes that intervened between stimulation and mechani-cal response in plants. He initiated the inves-tigation regarding the source of energy of mechanical response in plant organs, including the spontaneous pulsation of leaflets of *Desmodium gyrans.*

Both as Professor of Physics in the University College of Science and as Director of the Bose Institute, D. M. Bose trained and inspired a generation of scientists. He initiated several lines of investigation during his tenure. The time-variation and altitude-dependence of cosmic rays was measured using a Compton-Bennet type of Ionization Chamber. Several interesting cases of sudden variations in cosmic ray intensity associated with solar flares and magnetic storms were recorded. For work in neutron physics a 14.5 MeV neutron generator was fabricated and operated at the Bose Institute under Professor Bose's guidance. Incidentally, it was the first instrument of its kind to be installed in India.

"Bose was a man of few words, and more or less a silent worker, inspite of his vast erudition and wide interest," says S. D. Chatterjee, Professor Bose's colleague. "He avoided both the limelight of public applause and the patronage of the powers that be. His, nature and his uncompromising principles were praiseworthy."

Due to exposure to several cultural figures during his childhood Bose evinced keen interest in social and cultural matters. He was closely associated with the management of the City College and the Sadharan Brahmo Samaj. He served the Viswabharati University as its Honorary Treasurer for about 18 years. Professor Bose was deeply interested in the history of science. He was one of the editors-in-chief of *A Concise History of Science of India*, a publication of the Indian National Science Academy (INSA). He was also the editor-in-chief of the *Indian Journal of History of Science* published by INSA.

Professor Bose had been in the habit of taking long walks. But while in Germany he started suffering from arthritis. This put an end to his walks. But still he would walk to the Bose Institute and back home a few times every day. Eventually, failing health forced Professor Bose to take retirement from the Institute. He passed away in the morning hours of 2 June 1975.

NATIVE GENIUS

Ardaseer Cursetjee

RAJESH KOCHHAR

Public memory can be capricious. One victim of its indifference is Ardaseer Cursetjee (1808-1877), a marine engineer at Bombay, who became the first Indian Fellow of the Royal Society on 27 May, 1841, more than 75 years before the famous mathematician S. Ramanujan had the honour,

Cursetjee came from a family which had a long history of service to the British in the field of shipbuilding. The founder of the dynasty was Lowjee Nusserwanji (Wadia) who was a carpenter at the Surat dockyard before he was brought to Bombay to build a dockyard. With Malabar teak and native workmanship greatly in demand, Bombay emerged as a major ship-building centre. Shipbuilding brought great prestige to the family. The government not only presented the family with silver rules, shawls and tides, but also with *imam jagirs.*

Soon, though, things were going to change. The use of steam engine in navigation virtually coincided with Cursetjee's birth in the early 19th century. Cursetjee, for his part, was more interested in steam machinery than in ship-building. It was thus that he moved from superintending "the construction of several fine vessels", to mint engineer, so that he could "devote himself to the study of steam machinery and the foundry business."

He soon showed his worth by building a one-HP engine, which he installed on his premises. It pumped water from a well to feed a small fountain. This was the first engine built in India and was still working a decade later. In 1833, Cursetjee obtained a 10-HP marine engine from England and installed it in a vessel named *Indus*, both engine and vessel being paid for by his father. *Indus* was the second steamer built in Bombay, after the *Hugh Lindsay* four years earlier. It was subsequently purchased by the then Government of Bombay. Cursetjee's efforts did not go unrewarded. In October 1833, he

was made assistant builder at Mazagaon, “the office being expressly established for him on the recommendation of the superintendent of marine.”

Cursetjee maintained a small private foun-dry at his residence, which was no doubt profitable. He fabricated many wrought-iron tanks for different ships, “among which were several holding upwards of 5,000 gallons”.

His next engineering feat was the installation of gas lighting. By 1834, he lighted his bungalow and gardens at Mazagaon, using gas.

The governor visited Cursetjee’s residence and presented him with a dress of honour. More importantly, he brought this to the notice of the court of directors.

Very soon, the newly established Elphinstone Institution requisitioned Cursetjee’s part time services. It had a British professor of mathematics, astronomy, and all branches of natural philosophy, but no one who could teach the practical sciences. Cursetjee was asked to assist the Institution “in instructing the natives”, especially in mechanical and chemical sciences. Three years later, he was elected a non-resident member of the Royal Asiatic Society of England.

Cursetjee soon decided to spend a year in England to perfect his working knowledge of marine steam engines. He had taken permission from the government, but his departure from Bombay took longer than planned. He first asked the governor if he could accompany him to England. Apparently, Cursetjee’s as-sessment of the mutual relationship was not shared by His Excellency, who politely declined. Cursetjee made a trip to China to get over the snub. Next, he was offered a free passage on a government ship, but sudden illness grounded him. Finally, a year later, he left by the same vessel, paying Rs 1,000 for the passage.

He took his servants along, because he only ate food coked by Parsis. Indeed, he would never share a table with a non-parsi either. Once in England, Cursetjee appealed to the liberality of the court of directors for a subsistence allowance to meet expenses “which are indispensable to my respectability”.

Fortunately, he was given a daily allowance of one pound for a year in addition to his Bombay salary of Rs 79 a month. That he really needed this special allowance for his “respectability” is clear from his insistence on taking his own servants along when *The Times* proprietor, Mr. Walter, invited him to stay over for a few days.

In matters of religion, Cursetjee was a severe traditionalist. He did not approve of the lack of propriety of a young Parsi not donning the traditional cap in England. For all his conservatism though, his stay in England was hardly monotonous. As is clear from his diary, his visit encompassed more than the study of steam engines. He was summoned to attend a meeting of a House of Commons committee, to give evidence on the opium question. He spoke against the company’s opium policy, noting with satisfaction that his evidence had the approval of “that great friend of India”, Sir Charles Forbes.

For all his hyperactivity though, he was not too impressed by London. He found the royal mint considerably inferior to that at Bombay. He considered the cab drivers to be an “impos-ing and insolvent set of men”. And he castigated London’s “dirty roads”, comparing them unfavourably with Bombay’s.

Professionally, however, Cursetjee's British sojourn was very successful. He became an associate of the Institution of Civil Engineers, a member of the Society of Arts and Science, and of the mechanical section of the British Association for the Advancement of Science. He was appointed chief engineer and inspector of machinery in the Company's steam factory and foundry at Bombay, with the court of directors approvingly taking note of his testimonials. The post carried a salary of Rs 600 per month, more than seven times his then salary as an assistant builder.

While in England, Cursetjee was nominated to the fellowship of the prestigious Royal So-ciety. His name was proposed by influential persons. They included the then and two future presidents of the Institution of Civil Engineers, the future chairman of the East India Company, and the future president of The Royal Society. That was in 1841.

When Ramanujan was elected a Fellow in 1918, he fitted in with the Society's image as a body comprising eminent scientists. But in the early decades of the previous century, The Royal Society was also a club of gentlemen "curious in natural history", well acquainted with mathematics and engineering, or "conversant in various branches of experimental philosophy". In terms of the Society's norms then in vogue, Cursetjee would have been classified as a distinguished engineer, and as one who was attached to science and anxious to promote it.

Cursetjee's fellowship of the Royal Society remained strictly a private honour. It did no advance his professional career in any way, nor did it impress his countrymen. In the meantime, he returned to Bombay, and took his new charge on 1 April 1841, becoming the first native to be placed over Europeans. His staff consisted of one chief assistant, four European foremen, 100 European engineers and boiler makers, and about 200 native artificers. It burned many a European heart. The *Bombay Times,* a newspaper with a bias in favour of colonial rulers, did not approve of his appointment. It wrote, "We doubt the competency of a native, however able or educated, to take charge of such an establishment as the Bombay Steam Factory with a body of Englishmen to be directed, superintended and controlled".

Considering the controversy over the ap-propriateness of appointing an Indian to direct Europeans, it was just as well that Cursetjee made a success of the job. He visited America and selected woodcutting machines to be sent on to Bombay.

In February 1851, Cursetjee launched a 80-tonne steamer called *Lowjee Family.* Its speciality was that every part of this ship was indigenously fabricated at Ardaseer Cursetjee's own foundry at his residence. And he introduced Bombay to the sewing machine, pho-tography and electroplating. Besides the job, he was a success, as is clear from his being elected a justice of peace in 1855.

It is surprising that for all his achievements, he remains virtually unknown. Even the two-volume *History of the Parsis* by D. F. Karaka (published 1884) does not mention him, though 17 pages are devoted to his family.

Perhaps Cursetjee's obscurity is on account of the disinterest relating to colonial science in Bombay; at least among those leading the scientific field in Calcutta. So not only has India's first modern engineer not became a role model for his countrymen, but he is not even remembered as a historical curiosity. But, even now, it may not be too late to do justice to his memory.

CHOLERA TAMER

Sambhu Nath De

BIMAN BASU

In the history of science, one occasionally comes across individuals who in their lifetime never clamoured for the limelight despite having made contributions that can be termed as path breaking. Sambhu Nath De was such an individual whose researches revolutionised our understanding of the killer disease cholera. Yet he died unsung and unhonoured, even in his own country. It is largely because of De's work that cholera is no longer the dreaded killer it was only a few decades ago. His work set in motion a dynamic new era of cholera research which in turn has led to oral vaccines against the disease.

That cholera is caused by a bacterium called *Vibrio cholerae*, was discovered more than a hundred years ago in 1884 by the British physiologist Robert Koch who also demonstrated that the disease was water-borne. But Koch was unable to work out how the bacterium produced the typical symptoms of the disease— the uncontrolled 'rice-water' diarrhoea. As a result, the only measures that could be contemplated to prevent the spread of the disease were better sanitation and other public health measures. Then, in 1959, almost three quarters of a century after Koch's discovery of the causative agent came the discovery of the cholera toxin — the substance that actually produces the symptoms — by S.N. De. Using a novel technique to artificially produce the symptoms of cholera in rabbit intestine, he demonstrated that the real causative agent was an exotoxin, that is, a toxic substance that is released by the bacteria and not the bacteria itself. This finding opened up an entirely new area of cholera research and offered new pos-sibilities for its control.

Sambhu Nath De was born in a small village, called Garibati, on the west bank of river Hooghly about 40 km north of Calcutta. After finishing his schooling at the local high school, he joined the Hooghly Mohsin College. Later, after receiving a scholarship in his inter-science examination he was admitted to the Calcutta Medical College. It was during his stay here that his talent was spotted by one of his teachers, Prof M.N. De, a professor of pathology and bacteriology, who was greatly im-pressed by this young man's performance and nature.

After passing his M.B. examination in 1939, De took the diploma in tropical medicine in 1942. In the same year he took up the job of a demonstrator in pathology in Calcutta Medical College. Here, while working under Prof B. P. Trivedi, he published a few papers jointly with him during the following few years.

Meanwhile, De had married the elder daughter of his teacher Prof M. N. De, who had by then become professor of medicine at Calcutta Medical College. With Prof De's effort Sambhu Nath went to England and joined the University College Hospital Medical School in London in 1947 to work under Prof G. R. Cameron, FRS (later Sir Roy

Cameron) as a Ph.D. student. He was awarded the Ph.D. degree of the London University in 1949.

De returned to Calcutta soon after, a completely changed man. Recollects J. K. Sarkar, one of his close associates “...those of us who knew him from his student days were struck by the complete transformation in his outlook towards research which from now on was to become his yoga”. According to Sarkar, De started experimental work on the pathogenesis of cholera while at Calcutta Medical College, before taking up the Chair of Pathology at the Nilratan Sircar Medical College. “Apparently”, says Sarkar, “De had conceived the idea of working on cholera while in England as he brought with him from London small appliances for measuring blood pressure of cats, etc.”

De began his studies on the damaging effects of cholera on kidneys soon after joining Nilratan Medical College, where he had access to numerous cholera cases which were admitted to the attached hospital for treatment. He published several research papers on this topic between 1950 and 1955.

De’s success in elucidating the mechanism of action of the cholera toxin came out of not only his experimental skill but also his keen observation. We get a glimpse of these qualities of his and the series of events that led to the momentous discovery from his third Dr B.C. Roy Memorial Oration delivered at the Calcutta Medical Club in 1980. He said, “We entered the cholera field in early 1950... in our first experiment, heavy cultures of cholera Vibrio were introduced into the lumen of the small intestine of rabbits after opening the abdomen under local anaesthesia. The animals had no diar-rhoea but they were dead by three or four days—just as Robert Koch and other early workers had noted. However, at autopsy on these animals we found that the huge caecum of these rodents, which normally contains pasty semisolid material, was full of semi-liquid faecal matter from which *Vibrio cholerae* could be recovered”.

The finding was puzzling, but De did not give up, rather he put forward the argument that in these experiments, fluid is poured out in the small intestine which accumulates “in the caecal backwater and cannot find a way out to manifest as diarrhoea.” To substantiate his argument De devised a novel technique. “We next bypassed the caecum, isolated a four-inch segment of small intestine by two silk ligatures, introduced a loopful of *V. cholerae* mixed with one cc of peptone-water medium, killed the animals the next day. We were happy to see that the trick worked and we had a suitable animal model. The loop was distended with about 15 cc rice-water fluid while the control loop receiving the sterile medium was collapsed. This represents cholera localized to a small segment of the intestine.”

It was by using the novel animal model that De was able to show, in 1958, that symptoms of cholera could be produced even by sterile bacteria free culture-filtrate of *V. cholerae*. This conclusively proved that the symptoms of cholera were produced by an exotoxin and not by an endotoxin as believed by Koch and other earlier workers. De’s findings were published in the British science journal *Nature* in 1958.

Apart from his classic work on cholera exotoxin, De and his co-workers also carried out extensive studies on diarrhoea produced by the common gut bacteria *Escherichia coli* especially in infants. Using the rabbit loop experiment they were able to show that in both cholera and *E. coli* diarrhoea, the symptoms were produced by similar mechanisms.

De retired from Calcutta Medical College in 1973, almost unknown despite his path breaking contribution in cholera research. A sort of recognition came in 1978 when he was in-vited to the 43rd Nobel Symposium on Cholera and Related Diarrhoeas held at Stockholm, which he attended. But ironically, he never received any recognition in India. He was not even elected to any of the professional scientific bodies in the country. As one of his close associates recalls, “De never went out of his way to enhance his position in academic or professional bodies in which he was known for his work. He maintained a distance from centres of power in such bodies — a fact which may account for the absence of any recognition to him by way of fellowship of an academy, awards or honours excepting the Coates Medal awarded by the Calcutta University in 1956 for outstanding research.”

According to those who knew him, “De was not the type who would enjoy large gatherings, seminars and conferences. He was happy in a small and intimate circle of friends and professional colleagues who were almost members of a family.”

John P Craig, a Professor at the State University of New York Health Centre, New York, U.S.A. has this to say about De’s model which helped his colleagues throughout the world continue research on cholera with greater confidence: “Many of us who have worked in this area took for granted the discovery of this seemingly simple model system. But, looking back, it seems the world needed the fertile mind of an investigator whose natural scientific instincts forced him to shun the conventional approaches... No matter how simple it may seem, his truly creative and novel piece of work which started a chain of events which, in turn, forever altered our concepts surrounding the pathogenesis of secretory diarrhoea.

De died in Calcutta, on 15 April 1985. Paying tribute to him in a commemorative issue of *Current Science*, Nobel Laureate Joshua Lederberg wrote, “Our appreciation for De must extend beyond the humanitarian consequences of his discovery....he is also an exem-plar and inspiration for a boldness of challenge to the established wisdom, a style of thought that should be more aggressively taught by example as well as precept.” Nothing can describe better the achievement of De.

STORMY PETREL

Biresh **Chandra Guha**

HASAN JAWAID KHAN

India’s freedom struggle had people from all walks of life contributing their mite. Aristo-crats and farmers, landlords and labourers, politicians and businessmen, and even scien-tists — all helped in their own way to free the country from the shackles of imperialism. One such scientist who struggled for India’s freedom but at the same time did pioneering work that put him in the forefront of Indian science was Biresh Chandra Guha.

A doyen of Indian biochemists, Guha will long be remembered for his extensive work on the biochemistry of Vitamin C, the B-Vitamins and food and nutrition. His most important contribution is on ascorbic acid biosynthesis. Besides that, he was the man who established Biochemistry as a separate discipline in India. The idea for the Food Technological Research Institute now based in Mysore was also conceived by him.

A man with wide-ranging interests, Guha could recite freely passages from Kalidas, Tagore or Shakespeare. He was much in demand as a public speaker and could also write in a clear and attractive style. But Guha, the stormy petrel of science, is mostly remembered for his boldness and leadership qualities. “If one has to recall certain reminiscences of Guha’s private life, one thing would stand out pre-eminently and that is, his vigorous, ebullient, aggressive and often dominating personality,” reminisces B. Mukherjee, Guha’s close associate. “He was far from being a timid, quiet, passive and a non-interfering individual like many of his other colleagues at the University. He had the quality of a torrential stream gushing through gorges and not a placid, smooth current of water with gentle ripples on its surface.”

Guha was the youngest child born into the Guha Thakurtha family of Banaripara, in the district Barisal (now in Bangladesh). He was born on 8 June 1904. Being the youngest child he grew up under the strict supervision of his parents and elder brothers. This stood him in good stead when later in life his brothers, both professors in English, prevailed upon him to take up science in the intermediate course although Guha was much inclined towards taking up arts.

With his brothers having the upper hand, Guha had to take up the science course in the ,City College, Calcutta. Since Botany was not taught in the City College he studied Botany in the evening course at the Indian Association for the Cultivation of Science, which was then located at Bowbazar, Calcutta. After passing the I.Sc. examination in 1921 standing second in order of merit he took admission to the B.Sc. course with Chemistry Honours in Presidency College. However, those were the days when the Swadeshi movement was gathering momentum and young Guha found himself sucked into it. He was imprisoned for attending a banned political party meeting and sub-sequently asked to quit the Presidency College. Unruffled, however, almost immediately Guha managed to secure admission in the St. Xavier’s College from where he passed his B.Sc. in first class standing first in order of merit.

It was while studying M.Sc. at the Calcutta University that Guha first came into contact with Acharya Prafulla Chandra Ray. Acharya Ray’s devotion to science, selfless idealism and patriotism left a great mark on Guha’s career. In no time he became one of the favourite students of P.C. Ray. After spending a year of his research career under Ray he proceeded to England in 1926. During the next 5 years he carried out pioneering biochemical investigations with particular reference to B-Vitamins in the laboratories of Prof Jack Drummond at the University College, London and Prof Gowland Hopkins, a Nobel Laureate, at the Biochemical Laboratory, Cambridge University.

Guha returned to India in 1932 with Ph.D. and D.Sc. degrees of London University. Although his London professors recommended him for the post of Professor of Biochemistry at the All India Institute of Hygiene and Public Health, he was not offered the post due to his political leanings. Guha then joined the Bengal Chemical and Pharmaceutical Works and initiated there many lines of work on the preparation of

vitamin concentrates and other biologically active compounds. However, it was only in 1936 that he got the opportunity to try out his original ideas on some aspects of carbohydrate metabolism, particularly on the biosyn-thesis of ascorbic acid, when he was appointed Professor of Applied Chemistry at the University College of Science, Calcutta. During the period 1936 to 1943, Cuba and his associates worked on the vitamin and mineral content of several types of Indian food, fresh water and sea fish used for eating purposes, on the factors affecting the biosynthesis of ascorbic acid in animal tissues and also on the nature and properties of oxytocin from the posterior pituitary gland.

Guha's contributions on ascorbic acid or the Vitamin C biosynthesis are by far the most recognised. It is known that all animal species except the primates and guinea pigs synthesize their requirements of ascorbic acid, and, therefore, do not become scorbutic or deficient in ascorbic acid. The significance of Guha's work on ascorbic acid biosynthesis lies in its evolutionary implications. In the amphibians and reptiles, the key enzyme systems mediating ascorbic acid synthesis are localized in the kidneys or embryologically related tissues. In most birds the kidneys continue to be the main site for these enzymes. But in birds of the order Passeriformes (perching birds) and later orders, the liver takes over the function from the kidneys. In some species the synthetic function continues to be shared between the kidney and the liver. As evolution proceeded towards pri-mates, the ability of the liver to mediate the key enzyme reactions was lost. So primates had to depend on external supply of the vitamin for their survival. Guha's work has shown the importance of biochemistry as the connecting link between molecular genetics and species evolution.

The Bengal famine of 1943 was a shocking experience for Guha. The wanton suffering of millions of people shook him up completely and in effect brought him out from the ivory tower of his academic circles to become one of the most uncompromising advocates for the voice of science and the speedy implementation of policies. He applied all his knowledge of biochemistry and food technology to prepare cheap protein foods and digests for the treatment of extreme cases of starvation and emaciation. And, thereafter, he became actively interested in the problem of protein malnutrition. He was a strong advocate of leaf proteins as he realised the acute shortage of animal proteins in the country. He even developed a number of processes for the preparation of edible proteins from grasses and weeds considered useless such as water hyacinth.

In 1944 Guha joined the Ministry of Food, Government of India as the Chief Technical Adviser. Here he initiated plans for carrying out nutrition surveys for the whole country. He also organised a Technical Wing for inspection, analysis and standardization of foods. It was in the Food Department that he got the idea for a Food Technological Research Institute and gave the idea some concrete shape. Subsequently, when CSIR decided to establish such an Institute at Mysore, Dr S. S. Bhatnagar induced Guha to serve in its Executive Council for many sessions during its formative stages. It was also in 1944 at the rather late age of 41 that he got married to Dr Phul Renu Guha. A talented lady who later became a Member of Parliament, Dr Phul Renu Guha was a Ph.D. in Languages from a French University. Guha's marriage proved to be a turning point in his career. As B. Mukherjee opines, "But for the wise counsel and devoted guidance of his wife, Guha, with his indomitable spirit, aggressive mentality and a burning desire for breaking the shackles and obtaining freedom for his country, would have landed himself behind the prison bars and would be lost for ever to the world of science." The married

couple shared quite a few common interests in social welfare, music, culture, poetry and painting. The mar-riage did not produce any child though Biresh was very deeply devoted to young children.

While in the Food Department Guha was deputed to serve the UNESCO in Paris as India's representative and counsellor in Agricultural Sciences. On return to India he joined his earlier post at Calcutta University for a year and in 1948, persuaded by Dr Shyama Prasad Mookerjee and Dr B. C. Roy, joined the Damodar Valley Corporation as a member from West Bengal. Although Guha took up his duties in the Food Department and later the Damodar Valley Corporation with all the enthusiasm, the routine work, the general apathy and administrative delays were not to his liking. After almost ten years of administrative assignments, Guha once again came closer to his roots when he returned to the University Professorship in 1953.

Guha now found time to vigorously champion the cause of Biochemistry in India. He pushed the University Grants Commission to form a Biochemistry Review Committee. As a member of the Committee he visited all the University laboratories where Biochemical re-search was in progress. It was due to his efforts that the departments of Biochemistry at Calcutta, Lucknow and Nagpur were upgraded.

Guha had a dream. Of putting India on the biochemical map of the world. He had led the delegation of Indian biochemists to the International Congress of Biochemistry held succes-sively at Cambridge, Paris, Brussels, Vienna and Moscow. Guha had an idea of holding a Summer School in Biochemistry at Srinagar. He had gone to Lucknow to discuss the modalities with scientists of the Central Drug Research Institute. But destiny had planned otherwise. He died suddenly on March 20, 1962, in Lucknow, at the age of merely 58.

NUMBER WIZARD
Dattaraya Ramachandra Kaprekar

DILIP M. SALWI

It is often remarked that a message from an alien being or an alien world would contain the value of pi (Л), some prime numbers, and physical constants and so on. These values and numbers are well known and their presence in an interstellar message would indicate the mathematical acumen of the aliens. But, what would happen if a number such as 6,174 pops up instead in the interstellar message? Few astronomers — still fewer Indian astronomers — in fact, only those who have read Martin Gardner's writings on mathematical recreations in the magazine *Scientific American* would be able to decipher what the number 6,174 stands for. 6,174 is now universally known as the Kaprekar constant, named after its discoverer, Dattaraya Ramachandra Kaprekar, the mathe-matician who was laughed at by most contemporary Indian mathematicians for his 'trivial' play with numbers and who died almost unrecognised and unsung at the age of 83. Perhaps, had that American mathematics populariser Martin Gardner not noticed his work and not mentioned his contributions in Scientific American columns in 1975,

Kaprekar would not have received the little recognition that he received before his death. His mathematical contributions appeared so simple — needed only a pencil and some paper — that few mathematicians used to complicated theories and equations, could appreciate their worth. Today, Kaprekar constant and his other important contributions to the field of numbers, namely, self-numbers, demlo numbers, and so on are recognised the world over for their recreational value.

Kaprekar was born at Dahanu, near Bom-bay, on January 17, 1905. When he was barely eight years old his mother died. His father, who was a clerk in revenue office, tried to teach him whatever little mathematics he knew. Being an expert astrologer he taught young Kaprekar astrology. As astrology is a play of numbers, young Kaprekar was introduced to the world of numbers through it. Numbers fascinated him so much that Kaprekar began to play with them round the clock. His goal was to solve a mathematical problem in the shortest possible way. Soon, mathematical puzzles, tricks and doubtful and difficult questions caught his attention. During his school days at Thane, some of his classmates used to laugh at him for wasting his time on numbers; others watched him with fascination and admiration as he played with numbers. In 1923 he joined Fergusson College, Pune, where he received the Wrangler R. P. Paranjpe Mathematical Prize for his original piece of mathematical work. After graduation he took up a teachership in a school at Devlali, near Nasik, Maharashtra. He contin-ued to teach in various schools in Devlali till his retirement. Intelligent students and teachers admired him and appreciated his method of teaching mathematics. Kaprekar had the knack of imparting the joy he himself felt while playing with numbers to his students and other teachers. He was, therefore, often called upon by various schools and colleges to deliver talks and lectures on numbers, mathematical puzzles and curiosities.

"A drunkard wants to go on drinking wine to remain in that pleasurable state. The same is the case with me in so far as numbers are concerned," Kaprekar once remarked about himself. Give him some sheets of paper and a pen with enough ink, and Kaprekar would be lost in the world of mathematics, unconcerned about food and clothes. Often he would tie a rope instead of a belt, would carry biscuits in his pockets in case he suddenly became hungry while playing with numbers, and would treat everyone, whether his principal or students, with equal humility and respect. Simple by nature and a deeply religious person, he had a child-like attitude towards life and mathematics. He was therefore often misunderstood. Most Indian mathematicians scoffed at his discoveries and laughed at his antics calling them "too trivial" to deserve any notice. Nevertheless, Kaprekar continued his play with numbers, got his discoveries published in In-dian and foreign journals and corresponded with western mathematicians working in num-ber theory.

In 1962 Kaprekar retired at the age of 58 when he was drawing a monthly salary of Rs 150. Naturally, he could not have had enough pension to make his two ends meet. Four years later, his wife passed away, leaving him alone to fend for himself. To survive, he began to take tuitions in mathematics and science, and started charging a nominal fee for his lectures and talks on recreational mathematics. But as the saying goes, when the spirit is willing nobody can stop a person from achieving what he has set himself for. He used to cook his own food, wash his own clothes and perform all household chores. Despite ail odds he contin-ued his pursuit with numbers, spending as much as 15 hours on them every day. He also began to publish booklets on his discoveries, puzzles and problems.

His books, 30 in all, are easy to understand for undergraduate students and have stimulated several amateur mathematicians to take up recreational mathematics. Indian mathematicians began to recognise his contributions only after Martin Gardner wrote about him and his discoveries in his popular ‘Mathematical Games’ column in the March 1975 issue of *Scientific American.*

Throughout his life Kaprekar was only interested in number theory, the branch of mathematics which has much recreational and entertainment value but no direct use or application in any other field. Take, for instance, the Kaprekar constant 6,174. It is a constant in one sense. Take any four digit number such as 7823 in which not all digits are alike. Arrange the digits in descending order and reverse them to form a new number; 7823 becomes 8732. The reversed number is 2378. Subtract the new number from the first number. 8732 minus 2378 is equal to 6354. Again, arrange the digits in descending order, reverse them, and subtract the new number from the first number. For instance, 6354 becomes 6543 and reversed becomes 3456; then 6543 minus 3456 is equal to 3087. This is what is called “Reverse subtraction process”, which if repeated with remainders, leads to Kaprekar constant after eight or more steps. The constant generates itself thereafter. Today, this constant may sound trivial but it took Kaprekar about three years of juggling with numbers without the aid of a calculator or a computer to discover it. He announced his discovery at the Madras Mathematical Conference in 1949. The American journal *Scripta Mathematica* subsequently published his paper on the constant.

In 1949, Kaprekar also discovered what he called “Self-numbers” — *Swyambhu.* He later proved that there are infinite such numbers. To understand self-numbers, one has first to know what Kaprekar called “Digitadition”. Take any positive integer and add to it the sum of its digits. For instance, for 47, 4 plus 7 is 11; 47 plus 11 becomes 58. The new number 58 is called a “generated number” and 47 the gen-erator. This process can be repeated forever forming the digitadition series: 47, 58, 71, 79, 95,.... Kaprekar called a number which has no generator as a “self-number”. He said, “It is self born”. 1, 3, 5, 7, 9, 20, 31, 42, 53, 64, 75, 86, and 97 are the self-numbers below 100 which cannot be generated by digitadition process. Self-numbers which are primes are called “Self-primes”, “Why is a millionaire such an important man?” asked Kaprekar in one of his books and answered himself — “...because 10 is a self-number”.

In 1923, while waiting for a local train at Dombivli station (on the Bombay-Thane line) Kaprekar discovered what he later called “Demlo numbers”, after the name of the sta-tion. Earlier, he was struck by the common occurrence of numbers such as 165, 2553, 47773 on wagons, motor cars and tickets when he used to travel between Dombivli and Bom-bay V.T. A Demlo number consists of three parts; the first and the last part of this number when added results in a digit which gets re-peated in the middle part. For instance, 79992 is a demlo number because 7 plus 2 is 9; similarly, 588883 is a Demlo number because 5 plus 3 is 8; 247777753 is a demlo number because 24 plus 53 is 77; and so on. A Demlo number is generated by a process which Kaprekar called “demlofication”. In demlofication, one goes on adding numbers diagonally, or in other words, one goes on shifting each successive number one place to the left and then adding them all together. For instance, for the number 351:

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 351
351
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351

351

The addition is 389961

where 38 + 6l = 99

In other words, demlofication is an addition process in which the numbers following the first number are multiplied by increasing powers of 10 (10^1, 10^2, 10^3) before they are added together to produce the demlo number. Similarly, 724 gives 080 444444 364 after nine steps. Zero has been placed on the left of the number to form 080, a three digit number to correspond to 364 on the right. So, any number can be taken and turned into Demlo number by demlofication. “His Demlo mine seems to be inexhaustible and has drawn several gold diggers from distant parts of India to try their luck in his quarry,” said one eminent mathematician. Besides, he was extremely fond of magic squares involving dates and discovered some curious ones such as “Copernicus Magic Square”, “Mahatma Gandhi Shatabdi Square” and “Independence Square”. He also made several interesting contributions to mathematical magic’s and puzzles and prepared several models for demonstration.

Kaprekar died in 1988 at Devlali, unsung and unrecognised. He figures as an eminent mathematician only in *The World Directory of Mathematicians* published in Sweden. It is high time somebody should dig into his personal dairies, correspondence and other material which he painstakingly maintained throughout his life. Quite likely, it would throw new light on his work and give new insights into his wonderful mind.

SPEAKING FOR SCIENCE

Master Ramchandra

S. IRFAN HABIB

One of the major presumptions about the progress of knowledge in the erstwhile British colonies had been that it was mostly an import from the West. This ideological bias is still held by some as valid, yet majority of the serious scholarship has moved away from it. The Arabs are no longer considered as mere transmitters of ancient Greek knowledge. There are enough evidence to prove that the Greek scientific works were translated and researched upon before being passed on to Europe.

Indian contributions to scientific knowledge over the centuries have been no less. To speak of one such instance, if one looks at the intellectual climate and people’s perception of science in the 19th century, one comes across the name of Master Ramchandra, a mid-19th century intellectual and mathematician of Delhi — a man who wrote forcefully against unscientific beliefs and superstitions, besides several articles and books on popular science subjects. He had been a pioneer Urdu journalist, considered to be one who belonged to the *avant garde* of realist writing in Urdu. His *Haqeeqat nigari*

(realist writing) was actually representative of all the cultural figures of Delhi who included men like Alauddin Khan Alai, Munshi Pyare Lal Ashob, Syed Ahmad Khan, Mirza Ghalib, Altaf Husain ‘Hali’, and many others.

Ramchandra was born in 1821 at Panipat in a Kayastha family. His father Rai Sunder Lal Mathur was an employee of the revenue department, posted at Panipat when Ramchandra was born. Otherwise, the family had lived in Delhi and was very much part of the culture of Shahjahanabad. He was brought up and educated by his mother as his father died early when Ramchandra was just nine years old. According to tradition, he had his early education at home and was admitted to an English school in 1833-Ramchandra excelled at school and earned scholarship to take care of his minor expenses. He was particularly bright in mathematics which he pursued on his own as there were no arrangements to teach the subject at school.

He was married early at the age of eleven, but unfortunately, his wife was deaf and dumb. Despite the economic hardships and the difficulty of caring for an invalid wife, Ramchandra single mindedly pursued his academic activities.

He became a science teacher and mathe-matician at Delhi College (present day Zakir Husain College at Ajmeri Gate). In this capacity he wrote a book on mathematics in Urdu called *Sari-ul-Fahm,* where he tried to bridge the algebraic tradition of the Indian and Arab worlds and the more modern concept of mathematics that had emerged in the wake of the new calculus. He went on to write two books in English called *A Treatise on Maxima and Minima* (published in England in 1859, at the insistence of Augustus De Morgan, a British algebraist and logician) and a second work called *A Specimen of New Method for Differential Calculus called the Method of Constant Ratios* (published from Calcutta in 1863). These books were written in English which shows that they were not intended merely at Indian readership but were written to raise a peda-gogical issue that was essential Co the teaching of calculus even in the West.

Ramchandra was convinced, as seen in these books, that the Indian and Arabic tradi-tions of mathematics were essentially algebraic and so set about developing a calculus that did not require a deep foundation in geometry. So the first book begins with a knowledge of the theory of equations as found in Bhaskaracharya’s *Bija-Ganita,* and then pro-ceeds to obtain the maxima and minima for any polynomial function. The second book of Ramchandra dealt with the foundational problem in calculus. Here he tried to develop a more generalised method for calculus along the lines discussed in the earlier book. He felt that the *fluxional* method was problematic, since it was not free of the notion of limits. The *infinitesimal* method was suited for obtaining differentials, but was still grounded in the notion of limits. According to Ramchandra, the method of limits was the best available method though it required infinitely small and great terms.

Ramchandra was a great enthusiast of the vernacular medium of instruction. He felt that instruction in the mother tongue is more instinctive and natural, which was in marked contrast with the Macaulayan objective of producing clerks or to put aptly in Macaulay’s oft quoted words: ‘Indians in blood and colour but European in taste and manners.’ Ramchandra’s rationale for using the local language as the medium of instruction was that it would facilitate the task of communicating precious knowledge and will also enable the Indians to make the achievements of science their own, and thereby contribute to the development of knowledge.

Ramchandra took up translation of Euro-pean scientific works into Urdu, begun by Mr. Boutros, the principal of Delhi College. These activities were later formalised under the aegis of the Vernacular Translation Society. Ramchandra's papers *Fawaid-ul-Nazrin* and *Qi-ran-us-Sadain* were published initially by this Society. These papers sought to bring out what was good in the cultures of the East and the West and also present a unified viewpoint. *Fawaid-ul-Nazrin* carried articles of new in-ventions, discoveries and research in modern science and technology. Most of this work was in the French encyclopaedist tradition. All these popular articles were not merely project-ing the emerging world-view of science but they were reflective of his own reading of it. They were attempts to transform Urdu — a language known for poetic expression — into a vehicle for expressing social dissidence and commentary.

Ramchandra wrote prolifically on what he considered to be irrational and unscientific beliefs that had crept into Indian society over a period of time. He urged the readers to look at events and ideas rationally and not through traditional eyes. He writes about his prelimi-nary attempts in this direction:

"We were ambitious enough to imitate the plan of The Spectator. We first commenced a monthly, and then a bi-monthly periodical, called the *Fawaid-ul-Nazrin.*. in which notices of English science were given, and in which not only were the dogmas of the Muhammadan and Hindu philosophy exposed but many Hindu superstitions and idolatories were openly attacked. As a result many of our countrymen, the Hindus, condemned us as infidels and irreligious."

Ramchandra's critique of Indian society did not refract through the prism of European enlightened thinking, but was a part of those critiques which were emerging since the 18th century in the country. He wrote extensively in his *Fawaid* against the widely prevalent beliefs about *chhalawa, bhoot* and several such superstitions. He also tried to impress upon the people the fraudulent basis of magic, and that to be a successful magician one needs to know a little physics. He wrote a book as well, titled *Bhoot Nihang*, warning his countrymen against all sorts of superstition.

Ramchandra was in tune with the Baconian programme emphasising empiricism. He was highly critical of classical Indian scholasticism which confronted him in the debates with repositories of traditional learning, the pandits and the moulvis. Making a scathing attack on the traditional organisation of the *madarsas* and the method of education, he wrote in his paper:

"Gulistan is taught in schools. The teacher merely explains the meanings of various words to the student and then the student sits at a distance from his teacher, repeating the lesson like a parrot. He is not concerned about what Shaikh Saadi has written in *Gulistan.* He is concerned only with its literal meaning."

Unfortunately, neither Ramchandra's emphasis on the vernacular medium of instruction nor his pedagogic interventions in mathematics could find any takers in the post-Macaulyan phase. Ramchandra's project succumbed to the politics of power as well as to the politics of knowledge. He belonged to the Delhi Renaissance, which ran out of steam under a hostile political dispensation, and Calcutta was to emerge as the epicentre of modern science.

Ramchandra became a Christian in 1852 and his life was in serious danger during the 1857 revolt. Most of the Christians were sus-pected. So Ramchandra also had to run for safety with the help of his loyal servant. He remained in Roorkee as a Native Headmaster of Thomson Civil Engineering College but came back soon to Delhi as a Headmaster of Delhi District School in 1858. He retired early on health grounds in 1866, joined the services of the Maharaja of Patiala and took over as director of education in 1870. Most of his later life was spent in Christian missionary activities. Ramchandra's health deteriorated fast and he died on 11 August 1880, at the age of merely 59.

POPULAR SCIENTIST
Ruchi Ram Sahni

NARENDER K. SEHGAL

The multitudes of languages that add so much colour to the cultural diversity in India have been to some extent instrumental in the slow progress of science popularisation in this country. Attempts at popularisation of science in Indian languages have been few and far between. The earliest attempts can be traced back to the last quarter of the nineteenth century in Bengal in the form of popular science lectures and writings in Bengali. One such effort that spread throughout Punjab is a fascinating tale of a man's determination to popularise science in his province. The man was Prof Ruchi Ram Sahni who founded the Punjab Science Institute (PSI) in Lahore, in 1885. Within months of its establishment the Institute was regularly organising popular science lectures, throughout Punjab.

Professor Sahni who was the father of Professor Birbal Sahni, the renowned paleo-botanist, established the PSI with the main objective of popularising all kinds of scientific knowledge by means of lectures (in English and in the vernacular) illustrated with experiments and slides, as well as the publication of tracts. The PSI also encouraged technical education. Even some cash prizes were offered by a famous patron Malik Jowala Sahai for short papers on the manufacture of soaps, indigo and so on.

Members of PSI and most of those who promoted its activities were teachers (also called Professors) from various colleges. Those who gave popular lectures spent enormous amounts of time in preparing them, since these were invariably accompanied by well prepared slides and demonstrations of experiments to make them interesting, popular and absorbing. And all this work was done voluntarily by these individuals, without seeking any funds or grants from the government. An exemplar to this was Ruchi Ram Sahni. While working at Shimla, with the Meteorology Department as the Second Assistant Meteorological Reporter, he used to give popular lectures on 'Weather' with special reference to India and the monsoon phenomenon. These lectures were illustrated with charts prepared by him in the met-office — a few of them specifically for the lecture — along with lantern slides, also prepared by Sahni himself. These lectures cre-ated much interest and were attended by Indians and Europeans.

The interest and enthusiasm generated all over the Punjab province by popular lectures organised by the Punjab Science Institute could be gauged from the demands received by PSI from all over to send lecturers, and from the fact that it even decided to "charge a small fee at mofussil stations to cover at least part of the expenses incurred in sending most lecturers generally accompanied by a laboratory assis-tant and the necessary apparatus to illustrate the lecture". A fee ranging from 1 to 2 *annas* became a common feature at the popular lectures given in mofussil towns even when the lecturer was a local man. As a rule, in such cases, part of the apparatus and, very frequently, an assistant had to be sent from the headquarters. In ninety percent of cases it was Prof Sahni who was called upon to respond to these requests for popular lectures. The reason being that he had delivered so many popular lectures at Lahore and at other stations in Punjab that he was never at a loss for a topic for his lecture, or the appropriate apparatus to illustrate it.

According to a rough estimate, Prof Sahni must have delivered some 500 such popular lectures. Included among these was the annual course of some twenty lectures in the Punjabi language which he gave in the compound of the Baoli Sahib at Lahore. All these lectures were illustrated with simple experiments, often with simple apparatus which any one could make for himself. The large audience for these lectures consisted "almost entirely of shop-keepers from the surrounding *bazars* with just a sprinkling of English-speaking clerks from the offices".

Prof Sahni considered these to be his most successful popular lectures which, week after week, attracted a large number of shopkeepers at a time of the day when people were out making their daily purchases. Not only that, the audience was always forthcoming with suggestions whenever Prof Sahni found himself struggling for a correct Punjabi expression or word, for something he wanted to explain or describe. Each year, about ten of his lectures were devoted to very common everyday subjects such as "Soap-making", "The Water Lahoris drank before 1880", "Pure and impure air", "The toys and their lessons", "Electroplating", "Electricity in the service of man", "Glass-making", "The Punjab and its rivers (illustrated with a large relief map made in clay)", "The common flame", "How does the telegraph wire speak?", and so on. All these created much enthusiasm and interest in science. So much so that "there were more schools studying elementary physics and chemistry in Punjab than in any other province of India."

Every once in a while, Prof Sahni chose to speak on the latest scientific discoveries in his popular lectures; these proved a success far beyond his wildest expectations. In fact, his lectures on the newly discovered "X-rays", "Edison's phonograph" and "Wireless telegraphy" created so much interest that persistent demands came for their repetition, two, three times and even oftener at the same place. Also, the experiments on the wireless during these lectures were perhaps among the earliest experiments repeated in India.

During his deep involvement with the delivery of popular science lectures and with the overall management of PSI activity, Prof Ruchi Ram Sahni had realised quite early that "no science teaching in the province was possible without the provision of ordinary facilities for the repairs of simple school apparatus". But all other members were so apprehensive of the likely difficulties even in undertaking repairs of scientific instruments, let alone manufacturing them, that no one supported the workshop idea put forth by Prof Sahni. Undeterred and convinced of the need, Prof Sahni established the

PSI workshop in 1888, with little or no spare money of his own but with the confidence that somehow, if he persevered with the project, success would follow!

Prof Sahni worked out an arrangement with a Railway workshop *mistri* (technician), Allah Bakhsh — who had some ordinary tools and a simple charcoal furnace with a single goat-skin bellows at his house — to prepare a few simple pieces of apparatus for him. This man, who was getting a salary of Rs 25 per month and making another Rs two by mending locks, making keys and doing other odd jobs for the neighbours, later became the Head mistry of the PSI workshop. To supervise the work, Prof Sahni used to spend four hours every day at mistri Allah Bakhsh's house. This meant real hard labour — preparing for his lectures and class work in the morning, delivering popular lectures and managing the PSI's popular lecture programme, attending to his official duties at the college, and then spending long hours supervising his new 'workshop' at the mistri's house. The simple items made in the workshop were sold to schools at cost price, or even less.

This arrangement continued for about a year. The workshop was then shifted to Prof Sahni's house, with Allah Bakhsh becoming a whole time mistri at a monthly salary of Rs 45. Prof Sahni had invested his entire savings of Rs 1500 as 'outlay capital' on the workshop. With a full-time mistri and a few unskilled helpers to begin with, the operations expanded manifold.

After some years, a "Lock and Safes" section was added to the workshop, as a side-enterprise, largely to keep such a large number of trained men occupied for half the day with lock-making. Other odd jobs were also being taken within a month of adding this section. Two types of locks were designed and produced into which no other key would fit and which could only be broke open is case of loss of its keys. So quickly did the demand grow for these locks that this section was making a net profit of Rs 100 per month. This measured the success of the scientific section of the PSI workshop; here was a source of regular monthly income which could make up any shortfall on the instruments side.

With widening experience, the workshop began handling repairs of more complicated apparatus. Prof Sahni's popular lectures all over Punjab helped spread the good reputa-tion of the workshop in the whole province. Even some PWD (Public Works Department) offices began sending instruments like theodolites and prismatic compasses for repair to the PSI workshop. Such opportunities involving overhauling and examination of the working of a variety of delicate instruments, helped raise confidence of the workshop mistries (technicians) who were then emboldened to undertake the manufacture of more advanced school and college apparatus. By the early 1890s the workshop had developed into a reputed institution for the manufacture of a fairly decent set of scientific instruments.

During a trip to Bombay, for some essential purchases of materials like brass, zinc and other metal plates, copper and brass wires of various thickness, Prof Sahni landed in a local English firm dealing in scientific apparatus. While inquiring about the order the workshop had placed with this firm, Prof Sahni came across the name of Hira Lal, a science instructor at Hoshangabad (now in Madhya Pradesh), who had ordered for Tate's air-pump with that firm. On returning to his residence, Prof Sahni shot off a long letter to Hira Lal, telling him about PSI, the PSI Workshop, and enclosing his own small

catalogue of apparatus available from the PSI workshop at half the prices quoted by the British firm and with an offer to send him everything on approval and on a returnable basis, if necessary, at the PSI workshop's expenses. This, subsequently, led to a longstanding relationship and the workshop enjoyed Hira Lal's patronage for a long while thereafter.

With a comfortable financial position, the workshop was able to send gifts of simple apparatus costing Rs 4 to Rs 7 each to some of the schools. All the five inspectors of schools in the province were informed, through a circular, about the history and progress of the workshop and its capabilities and were offered a set of a dozen selected pieces of apparatus produced by the workshop and a mistri to explain and demonstrate the working of all the instruments. Of these, the one to respond was Master Pyare Lal, the only Indian among the five inspectors. Others did not even bother to acknowledge the circular!

In the summer of 1893, Prof Sahni received an invitation from Namjoshi of Poona (a well known social worker in the cause of industrial advancement of the country) to attend an industrial conference to be held in the ensuing autumn. Here was an opportunity to bring the PSI workshop to the notice of a wider audience especially interested in new industrial undertakings.

The conference had appointed a three-member committee to examine the apparatus brought from Lahore and on display at the conference, and to present a report on the same. Surprisingly, the committee made its report confidential. No one was able or willing to tell Prof Sahni why. At last, Prof Sahni was told in confidence that, in effect, "the committee did not believe that the apparatus could have been made at Lahore or anywhere else in India". They were, in fact, convinced that the instruments exhibited were really made in England and that all that the PSI workshop had done was to remove the original varnish and replace it or coat a varnish of their own so as to give it the appearance of Indian origin, and the proof of it was the fact that with their own resources of skill and appliances in Bombay and elsewhere, they (the Europeans) themselves could not turn out similar articles!

With the permission of the President of the conference, Prof Sahni spoke for ten minutes about his workshop with special reference to the instruments that were exhibited at the conference. Prof Sahni stated that, in his view, the committee could not possibly have made it more flattering for the PSI workshop. For its comment meant only two things: But for the varnishing, the Lahore made apparatus stood on par with the imported apparatus in its efficiency and that the workshop in Lahore had been able to achieve a success that was admittedly beyond all the resources of the more advanced presidency of Bombay. Prof Sahni even challenged the report with three offers. First, he asked the conference to depute any number of individuals to visit the PSI workshop at Lahore to see the manufacturing of apparatus there and that the to and fro second class fare of all the deputed individuals will be provided by the workshop. Second, as an alternative, the Head Mistry could be left at Poona, Bombay or wherever the committee wished with the necessary facilities for the manufacture of the apparatus. All that they needed to guarantee in return was the salary of the mistri, for the time not exceeding a month. Third, that the conference could place a large order for any of the items of the apparatus with the workshop. As the asking prices were only half of the English prices, they would be the gainers.

This submission by Prof Sahni was greeted with loud applause and Prof Modak of Baroda (probably the Chairman of the reporting committee) came forward and embraced Prof Sahni. This was the start of a long association of Prof Modak with the workshop and with Prof Sahni.

This was not the only occasion when the workshop gained public attention. At the 1906 Calcutta Industrial exhibition, Prof J. C. Bose was one of the Committee of Judges for the section on scientific exhibits. He spoke of the workshop's contribution to the exhibition in flattering terms and the workshop was awarded a Gold medal.

The subsequent history of the workshop is a string of successes and achievements. The output increased, the sales mounted and its reputation spread to other provinces with or-ders coming from the most distant parts of the country.

With the passage of time, the quality of apparatus improved and more advanced and delicate pieces of apparatus such as resistance boxes and chemical balances were turned out. They compared favourably with most of the imported articles.

Yes, the workshop could never come anywhere near the best instruments used in re-search work. But the demand for even such of the delicate instruments that were produced by the workshop was limited that it was difficult to arrange for the calibration and reliable testing of these instruments. With a stronger effort at promotion perhaps a few more orders could have been secured. Probably in anticipation of these difficulties, Prof Sahni wanted the workshop to diversify its activities.

Prof Sahni was keen to add some new activity to the workshop. He thought of adding a section to make binoculars, and students microscopes for which a fairly sizeable de-mand had grown. He even went to Germany in 1914, with a large sum of money, to bring back the required appliances for grinding lenses. But the First World War broke out and he had to return home empty-handed, after spending a year in England.

Meanwhile, a new association, the Society for the promotion of scientific knowledge (SPSK), with objectives similar to those of PSI, had been established by some students of the Lahore Medical College with Dr C. C. Caleb as its president. By this time, Prof Oman, who founded PSI with Prof Sahni had left India. Prof Sahni got deeply absorbed in serious and complicated litigation in the Dyal Singh Will case which lasted for about 10 years. Several members of PSI had joined SPSK and there was not enough room for two institutions with same objectives to work. Prof A. S. Hemm, the Head of the Science Department where Prof Sahni was a faculty member took the decision of closing down PSI due to "certain practical difficulties" and of transferring all its assets to the new society under Dr C. C. Caleb. Thus came an end to the dream of Prof Sahni.

NATURAL CHEMIST

Puran Singh

KOLLEGALA SHARMA

The fag end of nineteenth century is a memorable period in the history of India, and for more than one reasons. It was the times when a nationalist fever struck the land ruled by colonialists. It was also the time when the eyes of natives were opened to the exploitation by colonialists of their rightful wealth of natural resources. It was also the time when the people of the land of ancient religions took notice of developments in modern science and education taking place elsewhere in the world. It is at such a period that a new breed of scientists flowered in the subcontinent and founded the base on which the edifice of today's Indian science rests. One such illustrious person was the Punjab chemist Puran Singh. The son of Punjab whom H. S. Virk, his biographer, describes in *The Indian Journal of History of Science* as "perhaps the first chemist of eminence born in Punjab", pioneered many chemical efforts, especially in the utilization of forest products and amidst great difficulties. Sadly, today his name remains largely relegated to history books.

Professor Puran Singh was born on 17 February 1881 in a small village, Salhad of Abbotabad district in Punjab. The village is now in Pakistan. He was a brilliant student during his school days and passed his F. A. examination from D. A. V. College, Lahore. At that time there was not much opening for further studies in the subcontinent as there were only three Universities, one each at such far off places like Bombay, Calcutta and Madras. The Punjab under Sikh rule had only traditional schools like Madrassas, *Pathsalas* and *Chatsals.* The situation did improve a shade when Oriental College was set up at Lahore, after the annexation of Punjab by the British. Here too teaching of science at B. Sc (Hons.) and M.Sc. was not available till the first quarter of twentieth century. Puran Singh, like many other youths of that time, had to go abroad to further his studies. In 1900 he went to Japan and joined Tokyo University to study pharmaceutical chemistry. No Maharajas came forward to sponsor Puran Singh's studies abroad and all his expenses were met by the funds raised by the enlightened Sikh people of Rawalpindi.

Puran Singh's student days at Tokyo were eventful, if not turbulent. The emotional young man in Singh made him to first become a Buddhist monk and later to change the mind, after a chance encounter with Swami Ram Thirth, and turn into a Vedantin. Religious adventures apart, Puran Singh also dabbled in student politics. He organized an Indo-Japanese club and began publishing a journal called the *Thundering Dawn* through which he strived to project to the outside world the travails of Indians under colonial rulers. Ail these activities brought him trouble. He was arrested by the British as soon as he landed in Calcutta. But for the pleadings of his parents, he would have spent many years behind the bars for such anti-national activities. However, his parents got him released and brought him to Lahore.

At Lahore, Puran Singh had to face the reality. He was jobless. There was hardly any opportunity for a foreign trained scientist in those days, although the number of such men compared to the present times was in just hundreds. Besides, he had on him the burden of debt, of the funds his poor parents had sought from their community to finance Puran Singh's studies. All these made Singh determined to put to profit his scientific knowledge. Enterprising as he was, Puran Singh set up a small factory extracting and manufacturing essential oils from geranium and citrus oils. The distillation unit at Anarkali bazar of Lahore was set up not with any sophisticated equipments but earthen and metal pots manufactured by local potters and blacksmiths. Despite such a crude set up, Puran Singh could obtain excellent results and even began selling his product.

Unfortunately, his enterprise failed to sustain as he could not pull together with his business partner for long.

After dismantling the distillation unit at Lahore Puran Singh joined as Principal the Diamond Jubilee Hindu Technical School. Two years later, in 1906, he moved to Dehradun to set up a soap factory which he sold off a year later to join the Forest Research Institute (FRI) at Dehradun as a chemist. Here he set up his own laboratory in the Department of Chemistry of Forest Products starting from scratch. His interest in essential oils was rekindled. With the atmosphere being conducive for research and suitable facilities on hand, Puran Singh delved full time into analysing, extracting and isolating essential oils from many forest trees and plants such as *Eucalyptus globulus,* geranium, winter-green, sandalwood. He also developed a new condenser for distillation of camphor oil. In fact, he was very keen on promoting the essential oils industry in India. Realising that a sound base of Chemistry of essential oils is needed for this, he determined the oil yielding qualities of many oilseeds. He is also known to have devised improved methods of extraction, distillation and purification of turpentine oil from various sources like *Chir* resin, the pine trees *Pinus khasya, Pinus merkusii* and *Pinus excelsa.* He pursued these objectives even after his retirement from FRI (he retired much earlier from FRI on health grounds).

After his retirement when he was under the employment of Maharaja Scindia of Gwalior, Puran Singh started cultivation of Rosha grass .and *Eucalyptus globulus* in barren lands and set up a factory to extract essential oils from these. The oil was being exported to England.

The British government was so impressed by these efforts that it gave Puran Singh 15 *morabbas* (squares) of land on lease for cultivation of Rosha grass. His work has also helped the essential oil industry indirectly in many ways. For instance, his determination of oil value of vandal-wood from south India and his work on cultivation of sandal-wood and extraction of oil from it promoted the sandal-wood oil industry in India. Puran Singh also collected a variety of oilseeds from forests and tested their utility as sources of essential oils.

Another industry which benefited from Pu-ran Singh’s adventures in chemistry was the fledging tannin industry in India. Tannins are a group of organic chemicals obtained from plants and used in processing leather. Puran Singh carried out studies on tannins of mangrove *(Rhizophora muocranata),* myrobalans, *Pistacia integerrima,* Arwal *(Cassia auriculata)* and walnut. He also extracted tannins from the Indian Oak *(.Terminalia tomentosa)* and Burmese myrobalans. Not only that, Puran Singh devised a chemical test, using freshly prepared nickel hydroxide, for the first time in India, for estimation of tannins. Till then tan-nins were being estimated crudely by using powdered hide.

Although researches at FRI and his preoc-cupation with essential oils diverted Puran Singh away from pharmaceutical chemistry — the field in which he had qualified — a close look at his works show that he had not ne-glected it altogether. For example, he took keen interest in the cultivation of drug yielding plants in the Indian forests. He even tried to assess the therapeutic value of some essential oils such as sandal-wood oil and wintergreen oil.

Chemistry was not the only interest that Puran Singh had. He was also keenly interested in literature and societal problems. For in-stance, he is known to have

wondered at the urge in some pregnant women to eat earth and suggested that it might be due to reasons similar to the ones which force Indian deer to eat earth — to replenish their body with mineral salts. Along with a British scientist, Puran Singh also devised'a" technique for manufacturing charcoal briquettes from Indian woods. Some engineers at IIT, New Delhi are now looking into reviving this technique.

There is also a patent in Puran Singh's name, of a novel technique for cleaning and discolouring crystal sugar from raw sugar. The technique was immensely liked by the sugar manufacturers of that time as it did away with the use of bone charcoal which was detested by the users for religious reasons. Puran Singh had invented the novel technique, in a field entirely new to him, at a time when not only facilities but also information in the form of research journals were very hard to come by. His efforts, therefore, were greatly appreciated at the Indian Science Congress (1925) held at Benaras Hindu University, Varanasi.

Puran Singh's literary works run into some two dozen volumes in English, Hindi and Punjabi. According to H. S. Virk, "his writings have a relevance to the present Punjab crisis and provide insights for finding a solution to the problem". "He was a great visionary who predicted the fall of communism and break up of Soviet Union", says Virk. As a poet Puran Singh has written great mystic poems which, he believed, had the quality of winning a Novel prize.

Although his scientific pursuits were little recognized in the country of his birth at that time, they were well recognized outside the country. He was a member of the Chemical Society of Japan and Royal Chemical Society of London, two prestigious institutions of chemists. The scientist, humanist and mystic poet died in Dehradun on 31 March 1931 at the age of 50.

THE CRUSADER

Mahendralal **Sircar**

DILIP M. SALWI

Today, India has a large number of scientific institutions and laboratories conducting both pure and applied scientific research. She can even boast of a large scientific and technical manpower — large indeed for a country which has gained Independence hardly a few decades ago. While much of this growth can easily be attributed to stalwarts like Homi J. Bhabha, Meghnad Saha and S. S. Bhatnagar, few know that much before the concept of national sci-ence became a reality after Independence, a Calcutta doctor Mahendralal Sircar, had not only thought about it but had gone on to build one of the foremost scientific institutions in the country, as long ago as in 1876. Called "Indian Association for the Cultivation of Science" it was the leading scientific institution in pre-Independence India and became famous world-over after the Nobel Prize-winning researches of C.V. Raman. If Raja Ram Mohan Roy is considered the father of science education in India, it was certainly Sircar who can be called the personification of

national science. He built the Association to encourage original scientific research among Indians at a time when Euro-peans believed that the natives were only good at "speculative and impractical theories". Although several bigger institutions have over-shadowed the Association today, it continues to enjoy the singular distinction of being the only institution in the country to have pro-duced a Nobel Laureate in science.

Born on November 2, 1833 to a family of farmers of Paikpara, near Calcutta, Sircar was brought up as an orphan in his maternal uncle's house in Calcutta. His brilliant intellect always fetched him scholarships both in school and college. Although he loved reading great works of English literature he felt the necessity of learning science because he could not grasp the advanced works of his favourite writers like John Stuart Mill and T. H. Huxley without it. He therefore took admission in Calcutta Medical College, where science was taught in a small way. Here he found himself in his true elements and won all medals, scholarships and prizes. It is said that had he not answered a question on medical jurisprudence based on a latest case which was not known to the examiner he would have secured the Gold Medal in the final LMS examination with a first class in 1863. In the meanwhile he had begun to give lectures on scientific topics to his own fellow students. His natural flair for exposition of science and command over the language enabled him not only to win over the public to science through his lectures but also to collect money for the institution he eventually built.

In a short while Sircar became one of the respected doctors of Calcutta and had a roaring medical practice. He was a strong proponent of allopathy and used to denounce any other medical practice openly. But a turn came in his life when he was asked to review a book on homeopathy — Morgan's *Philosophy of Homeopathy.* Basically Sircar had agreed to review the book because he thought by knowing the philosophy of homeopathy clearly he could have more arguments up his sleeves to condemn it. But, surprisingly, the book changed him. The philosophy behind homeopathy in the treatment of patients convinced him and won him over to its side. Instead of criticising the book he openly praised it, thus inviting open hostility from the entire medical community which began to ostracize him. It appalled him when he found that even his friends were not ready to listen to reason. In the columns of the *Indian Medical Gazette,* false charges were levelled against him and slanderous remarks passed. Then only it dawned upon him that there was something wrong in the Indian society which would be set right by the cultivation of science, which is after all the search for truth. He realised that if Indian society were to be regenerated the imbibement of science was a must. He, therefore, decided to popularise science among the masses by giving lectures on various scientific subjects.

Fully aware that no medical journal would publish his views any more, Sircar started his own publication *Calcutta Journal of Medicine* and began to air his own views on medical science and systems. In the August 1869 issue of the journal he wrote an article entitled "The desirability of a national institution for the cultivation of the physical sciences by the natives of India". In the article he made a strong plea to his countrymen to establish a scientific institution which would allow full-time scientific research facilities for Indians, so that they did not simply become passive observers of scientific advancements which were then revolutionising the western society. He was keen to build an institution on the model of the Royal Institution of London and the British Association for Advancement of Science with clear motives in mind. He wanted that the institution

should have total freedom from interference by the then British Government, should be controlled and run by Indians and should enjoy liberty of thought and judgement. Perhaps, he was influenced by the book *Reflections on the decline of Science in England* authored by the versatile scientist Charles Babbage who had founded the British Association for the Advancement of Science to inculcate scientific outlook among the British masses. Fortunately for Sircar, those were the days when intellectual Renaissance was sweeping Bengal. Three major universities had already been established and foundations of engineering education had been laid in the country. Raja Ram Mohan Roy, who had pioneered several social and religious reforms, had already pleaded for science edu-cation but had left it to the then British Government to take care of it. It fell to Sircar's lot to institutionalise it.

Sircar's article created a stir in Calcutta. Ishwar Chandra Vidyasagar and Bankim Chandra Chatterjee openly embraced the idea. Sub-scriptions and donations for the institution began to pour in. The first visible effect of the article was the introduction of an alternative science course for B.A. examination of Calcutta University. Meanwhile some scientists like Father Lafont, a Belgian missionary and astronomer also began to give popular science lectures and handed in the money collected at the gate to Sircar for building the institution. Taking into confidence Richard Temple, Lt. Governor of Bengal, Sircar also managed to persuade several Indian princes to contribute money generously for the laboratory of the institution. On July 29, 1876, Temple inaugu-rated the Indian Association for the Cultivation of Science at 210, Bow Bazar Street (sadly, this building no more exists today). It was the first step towards building up indigenous scientific research capability in the country after several centuries of apathy towards science. It was as though science in India had gained Inde-pendence.

It took Sircar seven years of struggle to turn the dream of the institution he had set down in his article into reality. Massive campaigning and hectic lecturing to collect funds for building the institution apart, he had to fight tooth and nail against a semi-political organisation called the Indian League. The League claimed that science education or research was a luxury for a poor country like India; it instead suggested setting up of technical schools so that the country could be industrialised. In fact, it went on to set up a parallel institution for technical education called the Albeit Temple of Science which was founded on April 28, 1877. This institution, however, never functioned properly and was eventually closed down. Meanwhile a vicious campaign against the ideas of Sircar was taken up. His institution was called his fancy. Orthodox public became his enemy because science was then (and even today) considered anti-religion and anti-God. Sircar responded by arguing that technical education alone was incapable of generating the appreciation for science. Technical skills were already available in the country but they needed scientific breakthroughs to elevate them to higher pedestals. Scientific research was, he claimed, the search for truth in the creations of God. When the Indian League realised that Sircar was about to succeed, it made a desperate attempt for a compromise. But when an open debate was held in the Senate Hall of Calcutta University, Sircar stuck to .his guns because he believed a compromise would be the death of his dreams. When the Association was eventually set up, it became the forerunner of the chain of laboratories and institutions which later came up in the country.

Unfortunately, when Sircar was alive, the Association could not rise above the stature of a school where science was taught and experiments conducted. Despite his best efforts

and campaigns for collecting funds, Sircar could not raise enough money to support full-time researchers. He once remarked, “We have two kinds of hoarded wealth in this country - one in the shape of the gold and silver and the other in the shape of intelligence. In order to liberate the latter, it is necessary to liberate the for-mer...” During the last days of his life, Sircar was so exasperated at the apathy shown to-wards the Association by the public that he felt he had wasted his time in building it! The only events which redeemed his faith in Indian intellectuals before his death in 1904 were J. C. Bose’s discoveries in radio science and P. C. Ray’s on nitrites. At the fag end of his life he said, “The ultimate success of my scheme will depend upon the fact of its being a national movement”.

Although Sircar died a disappointed man, he had laid the foundations of scientific re-search in the country. The University of Calcutta soon introduced honours and master’s courses in science. The Swadeshi enterprise, which had caught on in the meantime, also owed a lot to the Association because it could provide men who could apply science in the service of the country. And the biggest honour Sircar received when C.V. Raman gave him the credit for his discovery after receiving the 1930 Nobel Prize in physics. The Association, which celebrated its centenary in 1976, is today in-volved in multi-disciplinary scientific research in its laboratories at Jadavpur.

ROUGH RIDER

Kolachala Sita Ramayya

ACHALA JAIN and S. P. K. GUPTA

On way to work that morning in wartime Moscow he had his third brush with the Nazi bomb and had survived only because it was a dud. Now returning home by the metro while changing trains at the junction he was caught in the passenger rush at the foot of the escalator. As he looked over men and women in front, their heads oscillated in a disorderly manner, so much like molecules in Brownian motion, as they stepped on the escalator before riding up in a steady stream.

Kolachala Sita Ramayya, India-born and America-trained chemist working on efficient fuels and lubricants for Soviet tanks had witnessed the scene many times before but the paradox struck him only now. He suddenly realised that what was happening before him is what happens in a lubricant: the interaction of molecules depends on their medium and in interacting they change the condition of their medium.

Like a sleepwalker he reached home and, without taking off his jacket, began to sketch on a sheet of paper the contours of what was shaping before his mind’s eye: a lubricant is a special plastic (rheological) medium, and the interaction of its molecules (as well as the additive molecules) depends on the condition of the medium which itself gets changed as a result of their reaction.

Earlier mathematical models had not served to picturise this. Research workers including himself had till then drawn on the concept of a lubricant as an abstract medium in which the molecules, like fish in an aquarium, moved colliding periodically.

Everything was in fact the opposite: the medium was the property of molecules; it was like what molecules were in the process of interaction. For a clear understanding of the medium, a new approach was needed.

Ramayya now recalled an earlier dose call. While he was on duty on the terrace of his apartment as air-raid warden, he had calmly caught an incendiary bomb with a pair of tongs, drawn the sparkling thing along the terrace and coolly dropped it in the sandbox prepared in advance to meet just such a contingency, he had refused to accept the object as a weapon of death but watched those sparks as something related to lubricants, his professional preoccupation. But the thoughts the sparks had evoked got tangled amidst work and had been forgotten.

Now in the darkening room those thoughts came back, the sparks of the incendiary bomb were like sparks one got during autogenous welding, the sparks under the hammer of the blacksmith, the sprays of melting metal, the sparks from a volcanic eruption in the darkness of night—and the bright red lava that flows from the volcano.

That’s it! Ramayya saw in the flash what happens in the bowels of the earth. He visualised the boiling underground seas of magma. Before him suns were floating and from their insides emerged tongues of solar flares. He conceptualised a new state of matter which he called plastic. This concept gained credence as the plasma state after the achievement years later of controlled thermonuclear reaction.

From that discovery by Kolachala Sita Ramayya of the properties of the plastic medium developed a new branch of science —chematology, or the science of using combustible and lubricant material in technology — the chemistry of motor oils.

The idea that lay dormant after he watched the sparking bomb and came to the surface while watching commuters step on to the metro escalator found both supporters and detractors but was soon accepted. The first practical results of the new approach followed and the board of his Institute wanted to put the method for the State Prize. It had first to be tested in production trials at another institution.

Ramayya and his chief went to an enterprise on the Volga and the trials were successful. The Volga enterprise however held back the trial protocols. For two members of the Commission were from a rival institution which did not accept Ramayya’s theory wanted the trials to be repeated and the other two who accepted the theory had to concede to them. The opponents themselves had to concede after the new trials. By then the deadline was past for submitting the papers to the State Prizes Commission and Ramayya lost a chance to win the award.

This was no loss to science. Ramayya worked with persons who put his theory into practice, constructed together with him apparatuses and plants which made his method standard practice, and set up a new technology standard. Among his devices is DK-NAMI for determining the characteristics of oil. His colleagues at NAMI (Institute of Automobile Science in Moscow) nurtured each branch of his science with care.

It is to this science, called chematology in the then Soviet Union and tribochemistry in the West, that we owe fuels and lubricants specially tailored for different kinds of motors and engines in distinct operating conditions. Fuels and lubricants are not just the basic oils distilled from the crude in the refineries. They are blends of basic oils and judicially chosen additives designed to meet specific needs, and provide for fuel economy and

longer engine life. Kolachala Sita Ramayya was a pioneer when he started blending lubricants for a Chicago firm in the mid-20s and his wartime theories advanced in Moscow led to the creation of a whole new discipline of science.

"Do everything a better way—this is the highest yoga," is what his father, a priest in an Andhra village on what was then the boundary between the Madras province and the Nizam state of Hyderabad, inculcated in Lal Gobind, which was the name Ramayya was given by his parents. The other principle he imbibed from his father was satyagraha and it saved him from the path of terrorism he would have otherwise taken to in anger and protest over injustices he saw around him.

When he finished school and wished to study further, his father said, "Then, you must walk to Madras." The father wanted the son to stand on his own legs, not counting on help from anyone. And yet at every step he received help, even on the long road to Madras.

He met an uncle who was high district official and pressed into his hands a letter of introduction to an Englishman. The letter ensured that there would be no injustice done to the aspirant at the university entrance examinations. He was picked from the physical culture class to run for the university and made an outstanding mark as an athlete. But he had come to the University of Madras to gain knowledge in physics and chemistry. He studied well and wished to acquire much more than what was offered by the university which was significantly better in sports than in chemistry. Going abroad for studies was not all that simple then.

Informed that his father was on the death-bed, Ramayya cook the steamer but could see only the funeral pyre. The elder brother did not appreciate his plans for study abroad and, when Lal could not be dissuaded, conveyed the words of their father: "If you have to transgress the sacred laws (by crossing the seas), you should at least follow three precepts: Don't take alcohol, do not smoke, and do not marry a white woman." Not counting a solitary instance, Lal would never be drunk. He could not do without tobacco which became his companion. And, he married two white women.

The Englishman in Madras gave letters to his friends in America. A teacher who turned out to be an activist of the underground communist ring in the port persuaded a ship captain to give him a job aboard so he could earn his passage. The captain wanted the bribe for immigration people at New York to be given to him in dollars. Ramayya entrusted the two thousand rupees his fattier had bequeathed to a fellow student passenger for conversion. When the captain learnt the chap had vanished with the money, he told Ramayya: "The hell with you. Get into the stokehold." Stoking coal into the furnace tested the limits of his endur-ance. He not only survived the ordeal but won the other stokers when he alone was not sick during a Mediterranean storm.

The voyage introduced Ramayya not only to the fuel without which the ship would not move but to the lubricant — grease dabbed on the connecting rod of the engine that drives the ship's screw — without it would all be finished within minutes. He did not know then but a thin film of oil would arrest his attention all life and he would see the whole world in the process that takes place in the narrow gap between the axle and the wheel.

The captain would not give him anything for the services but the stokers forced him to shell out half of the bribe that got Ramayya past Immigration.

After a while in New York as dish washer and loader at a hotel, he went to Chicago where he was admitted by the chemistry department of the University. There came a time when he was like a naked beggar. Everything went for books and debt payoffs, and unable to secure a living he spent the nights hungry like a tramp, on a park bench. Ramayya soaked up everything. The unique spaces of the Great Lakes. The stench of Chicago gang wars. The roar of the main railroad. The rhythm of the Negro jazz. The silent fall of the maple leaves in the park where he spent the nights shivering from cold, hunger, fear of being discovered by cops.

He was broken in. And he accepted the fact he was already an American. His only thought was to survive, to get on to finish studies. The man who brought him some money was Ponnambalam, a Ceylonese who had received him on arrival in Chicago, befriended and introduced him to the Indian community and to a wider circle of expatriates from everywhere. They went one evening to a party at a communal home. There he met a girl, Cindy, who was captivated by his big, magnetic eyes; and he was struck by her astonishingly beautiful eyes. Cindy offered him a room from which she had moved out without terminating the lease. He accepted it. Better to sleep under a roof rather than upon a bench. They next met at a charity dinner party held by some do-gooders. Later they married, but very soon a crack developed in their relationship.

Cindy persuaded Ramayya to attend a charity dinner where would be present a person who could help him if convinced that his experiments were worth spending money on. He was then studying thixotropy of a dispersing system to restore the initial technical quality of lubricants destroyed by mechanical action. He had discovered very fast changes in the colloidal medium: from sol to gel and back-wards. Money was needed to set up experimental models. Life became easier when he got a foundation fellowship. He finished MS at the University of Chicago in June 1924—a year early because he got credit for his University of Madras degree. The day he got his degree he learnt he would get patents for measuring thixotropy and for extending the working life of motor oil. A very famous firm offered him a job with good salary and promotion opportunities. Cindy said: “Now I can speak to my parents about you.”

It was like a blow on his head. She realised her blunder and began explaining. If she had kept their marriage a secret it didn’t mean she was ashamed of him. He must understand their limitations, their prejudices. He was not listening and said suddenly; “Will you go with me to India?”. She tried to stop that line of conversation and when he repeated the question, she kept quiet. He collected his things and left, answering her why: “Because I love you, Cindy.”

Ramayya became a commercial traveller in the provinces for a retailing firm. But America speeded ahead, waiving him away as it would a fly. The person he looked for all over America to give him peace and hope was one Joe whom he met in New York. It turned out that Joe had in Europe briefly met Anand, the teacher who had introduced Ramayya to the ship captain in Madras.

Joe was working for an American firm in Russia when revolution came in 1917. He stayed on and was, while working in the Far East, captured by the American interventionist army, tried backing home and letting off blacklisted. Ramayya spent three

days in Joe’s flat reading up Marx and Lenin and learning from his new mentor the arithmetic of American entrepreneurship. He returned to Chicago, made up with Cindy and called at the firm that had offered him a job on his graduation day.

While it built a laboratory for him, the firm sponsored Ramayya’s specialist studies at Yale with facilities for practical work at its New Haven pilot plant. He earned his second Mas-ters in a surprisingly short time.

His laboratory was top class — co-workers, apparatus, equipment, everything. He attacked the problem of engine corrosion by motor oil.

He straight away saw that the character of friction was qualitatively different during different regimes of the engine. From that understanding came the idea of ingredients (solutions of weak acidity or weak alkalinity) that gave oil a definite buffer quality. They could reduce the friction of engine parts. Wilhelm Van der Henk, the firm’s chief executive, talked of a new era of motor building with their “velvety lubricant”. Co-workers, the Tindemann brothers, came up with the apparatus thought up by Ramayya that was very sensitive to smallest changes in lubricant components. They could now imagine clearly what happened in the thin layer of oil at the moment the load changed. The rapid increase in the number of rotations created a crisis: the lubricant was unable to adapt itself to the new regime and so led to corrosion. They thought up a machine that automatically registered the change in the rotations and accordingly poured different lubricants to the moving parts. The machine was even named: “The Velvety Kitten”. But Henk douched the idea with cold water, saying it would make the machine costly.

Ramayya’s team thereupon came up with the idea of making a lubricant that regulated itself with changing operating conditions. However, Ramayya was ordered not to speak to anyone about it nor work on it without the management’s clearance. The firm was now getting profitable Navy orders. The Tindemanns and co-worker Per Malyo were transferred to defence jobs, and the tempo at Ramayya’s lab was affected. When he protested, he was told that the management didn’t welcome the involvement of Lal (which it knew translated as Red) in “social problems”.

After returning to Chicago, Ramayya had been an activist of a suburban Marxist study circle but had declined to join the Party saying, “I sympathise with Marxism but I am not a communist. I am a humanist.” On the expiry of his contract, the firm offered Ramayya a rise and promotion to section chief. He thanked them but he was leaving for Russia.

Cindy refused to go with him and, failing to stop Ramayya, threatened to abort their child if he left. When he said she would have nothing to worry financially, she asked: “What will I do with a coloured child?” He answered: “We are going to a country where there are no whites and coloureds.” She carried out her threat when he went to New York only to discover Joe was dead. Leaving her, the house and the cheque book, he moved into a hotel.

At Russia, Ramayya became head of a laboratory at the petroleum institute and an-other at the tractor institute. There were not enough experienced workers and specialists but each did the work of two. There was no technical base but they supplemented the equipment bought abroad with what they could design and improvise from what was available.

He couldn't shake off Cindy from his thoughts. She was uppermost in his mind at moments of failure, at the time they devised an additive for tractor oil, at the May Day parade when he was surprised to find the column of his enterprise carrying his portrait. He missed her. She obtained his address from Ponnambalam so she could take him back to the States but never came to Moscow nor wrote. It would have been fruitless. For he had by then married and raised a family. Ekaterina Ivanovna was an unlettered orphan of German extraction driven by civil war, drought and hunger from village Povolze on the Volga to Moscow where she somehow found strength to work and adjust to city life. A certain similarity of their fates enabled her to understand Ramayya when they met. And it just happened that they married. Katya helped Ramayya to get used to his new country, to speak and think in Russian. So different in ethnicity, education and fields of interest, they yet achieved the "soviet of love"; in all their years together they did not fight even once.

When Hitler turned his armies into the Soviet Union, Ramayya as an Indian felt Russia was the only obstacle between fascists and his defenceless Motherland and asked at Voincomat (recruiting office) to be sent to the front. Just before being marched off, he was ordered out of the column of enlisted home guardsmen and taken to the commandant's office where the director of his institute told him: "Nobody doubts your patriotism but your head is required not as a bullet target but as a weapon." He was ordered to the rear. Within a year he was busy re-establishing the Institute while his family was moved to Siberia. Only work saved him, the work on tank fuel and lubricants.

The tank is not just an armoured tractor. The work regime of its engine is absolutely different. He had to find a fuel that kept the tank manoeuvrable as conditions changed its workload. The image of the tank as an elephant—hardy, fast striving and plastic in move-ment—gave birth to the idea that a plastic fuel would be appropriate for a plastic machine. Drawing on his American theories, Ramayya carefully tailored kerosene-type fuels for the battle tanks and developed high quality lubricants with special additives.

The change of fuel required modernisation of the engine. Soviet tanks with new engines operating on Ramayya's fuels and lubricants— reliable, trouble-free on the battlefield— proved to be superior to German tanks and were in no small measure responsible for victory.

Searching for new fuels and working on additives for tank lubricants, Ramayya was led by his bomb encounters to his concept of *'plasticheskaya prostranstva'* which can be roughly translated as rheological medium—a substance that flows and changes under stress and strain. Out of this concept was born chematology the science that had its Western reincarnation in 1966 as tribochemistry. This is a part of tribology or the science and technol-ogy of friction and lubrication of interacting surfaces in relative motion.

The basic concept is set out in the thesis, "The viscous anomaly in oil and its effect on friction in machine", which Ramayya wrote to obtain his doctorate in 1951. That it required another 15 years to re-emerge as tribology despite the availability of a Soviet journal in English specialising in chematology is a commentary on the cold war that bedevilled every-thing including science.

Rivalries within the Soviet scientific estab-lishment and suspicions arising out of his Indian origins also may have played their part in Ramayya not securing the kind of recognition from the Soviets he was entitled to by reason of his contributions to science and technology. He retired as head of NAMI department of fuels and oils.

Without giving up his scientific quest he also made his mark on the literary scene in Moscow. It was in a sense a second working life. He unwittingly got involved in helping Svetlana Dzenith in the compilation of a Telugu - Russian Dictionary and his circle of acquaintances widened to include philologists, linguists and translators. And, students of Telugu when he helped Nikita Gurev with his Telugu course at the University of Leningard. He was happy to be commissioned lo translate Etukuri Balaramamurty's *A Brief Survey of the History of Andhra People* into Russian in 1956. A visit to his house became a must in the 1950s for the swelling number of Indians — scien-tists, scholars, artists, writers, students — who went to Moscow.

Sergei Baruzdin, author of poems on India, called his life "a wonderful odyssey of an Indian Marxist". He was variously known as "Russian Andhra", "Moscow Andhra" and "So-viet Andhra". The basic thoughts of his last scientific work, "The Induction Period of Pre-cipitation—a new index of motor oil quality and effectiveness of additives in them", was published posthumously and deserves to be better known.

Busy with his routine work, he left behind only memories and a few scientific articles. His magnum opus, The Theory of the Plastic (Rheological) Medium, remained scattered in lectures. The workers of his publishing house "Progress" saw him off on his last journey. The cortege paused at NAMI for his scientific colleagues to pay homage. Ambassador Inder Gujral spoke at the funeral: "We are bidding goodbye to a great scientist, a great son of India and son of mankind."

MAN OF MIRACLE DRUGS
Yellapragada Subba Row

S. P. K. GUPTA

The tetracycline among antibiotics is like a panacea for a wide range of chest and urinary infections as well as for sexually transmitted viral diseases. They are easy to take as capsules and they are equally effective against them all. You may be one of the millions around the world who at some or the other time have swallowed a few of those capsules and went about your normal duties — never mind the fever — and felt completely well after a couple of days. No wonder an American magazine gushed about the capsule-maker: "You've probably never heard of Yellapragada Subba Row. Yet because he lived you may be alive and welt today. Because he lived you may live longer."

Subba Row did not find the panacea accidentally or fortuitously. He got it by methodically planning his hunt and carrying out the hunt laboriously, scientifically and conscientiously against odds that seemed apparently insurmountable. He, in fact, produced the first antibiotic which, contrary to general belief, is the gramicidin discovered by Kene Dubos and Dot penicillin on which Alexander Fleming chanced upon. Its bad side effects barred the use of gramicidin in medical practice. By the time the British had crude penicillin for experimental studies, Subba Row had it pure. When H.

W. Florey went to the United States to drum up enthusiasm for commercial production of penicillin, he found Subba Row's penicillin the most potent of any obtained by research workers. But Subba Row's laboratory was beaten in the race to reach penicillin to the war wounded because .his management would not let him join the "pool" of drug industry giants funded and controlled by the "creeping socialists" of the Franklin Roosevelt administration. Subba Row subsequently tried to help Selman Waksman with his tuberculosis-fighting streptomycin but frustrated because of the microbiologist's patent tie-up with a rival drug firm.

Subba Row was fed up running about with other people's antibiotics which were after all limited in the range of infections against which they were effective. He would, he declared to his colleagues, find an antibiotic that would be a "panacea", would neutralize a wide spectrum of disease organisms. He hired Benjamin Duggar, a retired plant physiologist, to screen the soils of the world for antibiotic producing bacteria and fungi, especially actinomycetes which look like fungi but live like bacteria. Duggar was 16 months into his steady supply of active soil isolates until one day in August 1945 Subba Row got a series of six yellow moulds sieved out from soil samples of a field in Columbia—a Missouri town 1500 kilometres west of Pearl River, New York state — where Subba Row headed research for Lederle Laboratories. These in the test tube were the most promising antibiotic-producing isolates until then, and Subba Row had them grown in corn steep liquor.

Subba Row, his fermentation experts and chemists spent the next 20 months coaxing the antibiotic out of the constantly scaled up tanks of broth and getting it out in pure crystalline form. He stalled the company administration's bid to cut staff in a recession year, ignored the scepticism of the company's own medical department, and took the antibiotic, named aureomycin because of its golden splendour, to the prestigious Johns Hopkins Hospital. 'There famed physician Perrin Long rejected it when his animal warren demonstrated that it was less spectacular than penicillin and strep-tomycin. His faith unshaken, Subba Row showed Louis Tomkins Wright the data on the havoc it wreaked on certain infectious viruses in animal hosts. Impressed, the distinguished Black surgeon administered aureomycin at Harlem Hospital to viral venereal diseases (VDJ patients for whom no effective treatment was available. All the four were cured within a week. Wright had not seen anything like that in 24 years of medical practice. Aureomycin was *a* million dollar drug if it cured only VD. Three California doctors than tested it in an epidemic of a mysterious viral fever and patients recovered dramatically. It was now worth its weight in gold but Subba Row felt laboratory tests justified pitting it against penicillin and streptomycin in bacterial infections. Perrin Long was now ready to listen, and aureomycin was indeed effective against urinary track infections. In nearly half a century of medical practice around the world, tetracycline's — aureomycin and a host of derivatives produced by manipulating its chemical molecule — have proved themselves against common urinary as well as chest infections including pneumonia, besides viral VD, and are drugs of second choice for syphilis and gonorrhoea patients allergic to penicillin.

Subba Row was successful also in a battle he waged longer with a disease that nearly cut short his own life in youth and took the lives of two of his brothers. The killer was tropical sprue, a vitamin deficiency marked by impaired digestion and concomitant anaemia. Subba Row picked up the challenge when colleagues at Harvard gave up, half

way, isolation from liver of the vitamin curative of pernicious anaemia. As a lowly staff member at the Harvard Medical School, he spent years upon years breaking up liver and probing fractions and fractions of fractions. After moving to Pearl River he had Vitamin 812 out of liver in a beautiful pink solution. A victim of inhibitions, he attributed the colour to a toxic precipitating agent and neglected the solution on the shelf until too late. Shortly after he got convinced that there was no trace of the toxic salt in the solution and permitted clinical testing, a rival research group announced the isolation of the pink vitamin which conquered pernicious anaemia. No matter. Folic acid, not B12, is the cure for sprue and Subba Row had wrested it from liver — in fact, five years before B12 isolation. But it cost a prohibitive 64 dollars a daily dose and a thousand pounds of pork liver had to be processed for just four doses. Fortunately a parallel group in Subba Row's laboratory crystallised folic acid out of broths inoculated with a member of the sour-milk (lactic acid) family of bacteria. But the process was not amenable for easy commercial exploitation and the costs were still high: nearly two dollars a daily dose. No problem. Subba Row's chemists meanwhile had chemically synthesized folic acid. The initial manufacturing cost was just a little over a dollar for a bottle of twenty-five 5mg tablets. He was still three years ahead of B12. Folic acid by itself and in combination with B12 is effective in a wide variety of nutritional ailments.

Initial misunderstanding of the role of folic acid was compounded by confusion over its chemical nature. There was a wrong lead that it might be helpful in cancer fighting. A New York hospital began to use folic acid from microbial broths — chemically different from liver folic acid and itself soon synthesised — in cancer patients and was enthusiastic about its palliative action in reducing pain and promoting a feeling of well-being. Subba Row had his own misgivings about a growth promoting vitamin serving as cancer inhibitor but supported cancer studies, tailoring chemical work to clinical reports. He soon had his "boys" producing folic acid antagonists which proved to be real growth inhibitors of cancer cells. One of them, aminopterin, brought about miraculous recovery of children suffering from acute leukaemia or blood cancer. A derivative, methotrexate, is one of the most potent drugs against cancer. Conquest of cancer became a magnificent obsession with Subba Row after reports of aminopterin success came in. He planned a cancer research institute and those who shared his dreams say he would have made the conquest had he been given ten years. But before his plans could get off the ground Subba Row died in his sleep on the night of August H/9, 1948. He was only 53.

In less than ten years Subba Row had produced an antibiotic, a vitamin and an anti-cancer drug besides an anlifilariai, diethylcar-barnazine, still the best guarantee against deforming elephantiasis. He had also broken the old vitamin monopolies by devising alternative processes for several members of the B-complex.

How has such a wizard of wonder of drugs, hailed as "miracle man of miracle chugs", re-mained an unsung hero? Especially when inti-mates believe he was a fame hunter? Subba Row was never able to recognise any of his accomplishments as worthy of the fame he sought as one who changed fortunes in man's fight against disease. Moreover he had been a *mere* director and he believed the limelight should play on the actor — the associate or the assistant who provided at the laboratory bench the key to the success of a particular project. Hence it was Benjamin Duggar whose soil screening had got him the golden bug that ate fever bugs right and left of the spectrum; it was Coy Waller whose heterodox idea was the cheapest way of making folic acid; it was Sidney Farber who

discovered the potency of anti-folics in leukaemia; it was Redginal Hewitt who noticed the anti-filarial activity of one of the hundreds of chemicals sent in for testing. Subba Row was always on a back seat in the auditorium when [he accolades were handed out on the stage.

Subba Row’s greatest successes at Harvard were achieved even earlier, during his gradu-ate student clays. With Cyrus Fiske as his guide, he devised a colour measurement of phospho-rus in blood and urine. In diagnosis of rickets, renal diseases, parathyroid hormone deficiency and over activity, and bone calcification, the Fiske-Subha Row method is comparable in value to the sugar test for diagnosing and monitoring diabetes. Subba Row in joint research with Fiske discovered phosphor-creatine and ATP (adenosine triphosphatc) which have unravelled a mystery of life: the source of muscular energy which keeps the world moving.

How Subba Row made his way to Harvard from the Andhra backwaters is in itself a fascinating saga. He was born a century ago in the Godavari delta into a family of niyogi brahmins. The boy ran away from the house of limited means to make a fortune in Varanasi by selling bananas to pilgrims, was captured halfway by Mother Venkamma and put back in school. Venkamrna sold her gold ornaments to send the young man to Madras city for a third attempt at matriculation and raised subscriptions from patrons of education for his college studies.

But Subba Row in the faraway city spent as much time at the Ramakrishna Ashram as he did at the Presidency College. The Mission could not accept him as a sanyasin without the mother’s consent and persuaded him to enter the Madras Medical College so he could serve the order as a doctor. When private scholarships dried up Venkamrna persuaded Subba Row to marry a girl whose family would finance his medical education. His first stop after graduation was Madras Ayurvedic College whose principal, Achanta Lakshmi Pathi, had saved his life when the allopaths could not treat his bout with sprue. As vice-principal of Lakshmi Pathi’s college, and editor of its journal, he tried to organise state-wide clinical trial of ayurvedic medicaments for elephantiasis by *vaids,* and prepared a compendium of medical herbs in an attempt to standardise them for use by all systems of medicine. With the principal drawn into politics of medicine, the college atmosphere was not conducive to research on any meaningful scale. Meeting an American conducting hookworm research in Madras, he learnt he can do research into tropical diseases in the United States. American professors were not interested in his ambition to put ayurveda at the service of modern medicine but they could teach him techniques he could on return apply to advance ayurveda. With a loan from his father-in-law against a promised scholarship from an Andhra charities, he earned a diploma from Dr Richard Strong’s Harvard School of Tropical Medicine at Boston. When the scholarship, not tenable for medical stud-ies, materialised he shifted to the biochemistry department of Harvard Medical School.

Subba Row for all his successes in medicine was at times discouraged. “We only prolong life,” he said. “We don’t deepen it.” This dis-satisfaction made him return to religion. Christ’s teachings made it “easier” for him, as it had for Mahatma Gandhi, to believe in God. He tried to follow Gandhi who said, “No act of mine is done without prayer.” He attended Community Church of New York where he endowed the pulpit named after its pastor Hohn Hayes Holmes and in honour of Mahatma Gandhi. He also

went to a neighbour-hood church and supported its educational activities. It was his way of participating in the service of a community of which he was very much an outsider despite his desire for integration. Despite his official status as an “alien”, he led and drove groups of white American citizens to make their utmost creative contributions to what the U.S. government regarded as war-effort. After the War, Indians became eligible for American citizenship and he got himself declared qualified but did not lake the final step that would have meant the renuncia-tion of his Indian citizenship.

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